NORTHEAST ELECTRONICS
Division of nt northern telecom
Airport Rd., Concord, N.H. 03301•(603) 224-6511•TELEX 94-3453

INSTRUCTION MANUAL

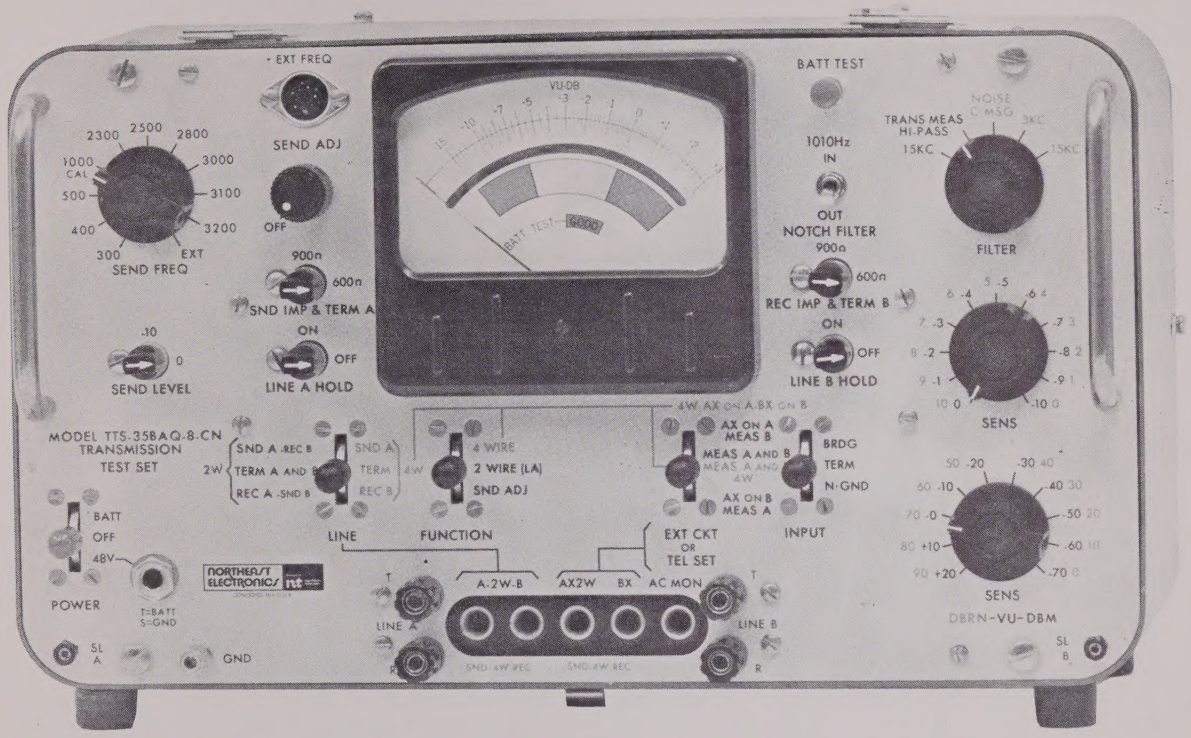
TTS-35 SERIES

TRANSMISSION TEST SETS

COVERS: TTS-35BAQ-8-CN, TTS-35BAQR-8-CN
TTS-35XDT, TTS-35XPS, TTS-35XV

PRINTED IN U.S.A. 5C-0035-1177

No. A0035-20-600 ISSUE 3 DATE NOV 1977



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SECTION 1

GENERAL DESCRIPTION

1.1 This manual provides operating and maintenance instructions for the TTS-35BAQ Series of transmission test sets. The manual covers both rack-mount and portable models. For the purpose of this manual the identification has been abbreviated to TTS-35 for portable models and to TTS-35R for the rack-mount models.

1.2 APPLICATIONS

1.3 The TTS-35 may be used to perform a variety of transmission level, noise and VU measurements on telephone circuits. These include tests on local exchange loops, two-wire circuits, four-wire toll circuits, and special service circuits. The TTS-35 is a simultaneous send/receive test set. Some typical applications are listed below:

a. Dial a test call through the test set and then talk on 2-wire or 4-wire circuits.

b. Recieve a test call through the test set, and then talk and test on 2-wire or 4-wire circuits.

c. Make transmission tone level receive measurements on 2-wire or 4-wire circuits.

d. Make balanced metallic noise or noise-to-ground measurements with or without 1010 Hz holding tone on 2-wire or 4-wire circuits.

e. Monitor circuit operation with a standard 52A headset.

f. Supply quiet terminations for circuit balance or noise tests on 2-wire or 4-wire circuits.

g. Measure gain or loss of amplifiers or other external equipment.

h. Provide external equipment access to a circuit under test through the test set.

i. Measure attenuation distortion.

j. Determine signal-to-noise ratio.

k. Measure circuit balance.

l. Provide loop holding for external equipment.

m. Make loop-around tests to determine near-to-far and far-to-near end losses.

n. Dial common test lines, and measure circuit performance on type 100, 102, 104 and 107 lines, for example.

Figure 1—1 shows the TTS-35 with its cover accessories in a typical test set up.

1.4 FUNCTIONAL DESCRIPTION

1.5 The TTS-35 transmission test set is a portable, battery operated unit. Functionally it consists of a **send** section for generating test tones, a **receive** section for measuring tones or noise, and a **switching** section for selecting test input jack connections.

1.6 The send section has an audio frequency oscillator capable of generating ten separate fixed frequencies with output levels adjustable from +3 dBm to −40 dBm. An external cover accessory, called the Model TTS-35XV Continuously Variable Frequency Adapter, is available as an option. It extends the frequency range of the send section.

1.7 The receive section measures VU, noise, and transmission levels. Measurements are displayed on a parallax-correcting, mirrored 4½-inch scale meter located on the upper front panel. The meter has three measurement arcs. The top arc is a combination scale for measuring VU units, power levels in dBm, or noise levels in dBrn. The middle arc is color coded in red, yellow and green (from left to right), and is used for approximating VU measurements. The bottom arc is labeled BATT. TEST—GOOD. It may be used to check the condition of internal batteries or external dc supplies.

1.8 The overall range of the receive section may be changed from −80 dBm to +20 dBm for tone levels (or from 0 dBrn to 100 dBrn for noise) using sensitivity switches on the front panel. The dBm marks on the sensitivity switches and the corresponding meter scale are printed in black. The dBrn marks are printed in blue. This helps distinguish between level and noise measurements.

1.9 The sensitivity switches also allow the TTS-35 to be used as a variable high-gain amplifier. An input signal applied to one of the front panel jacks may be measured and then amplified to the desired level. The amplified signal is present at an output monitor jack to drive external equipment. A headset may be used to monitor the tone or noise.

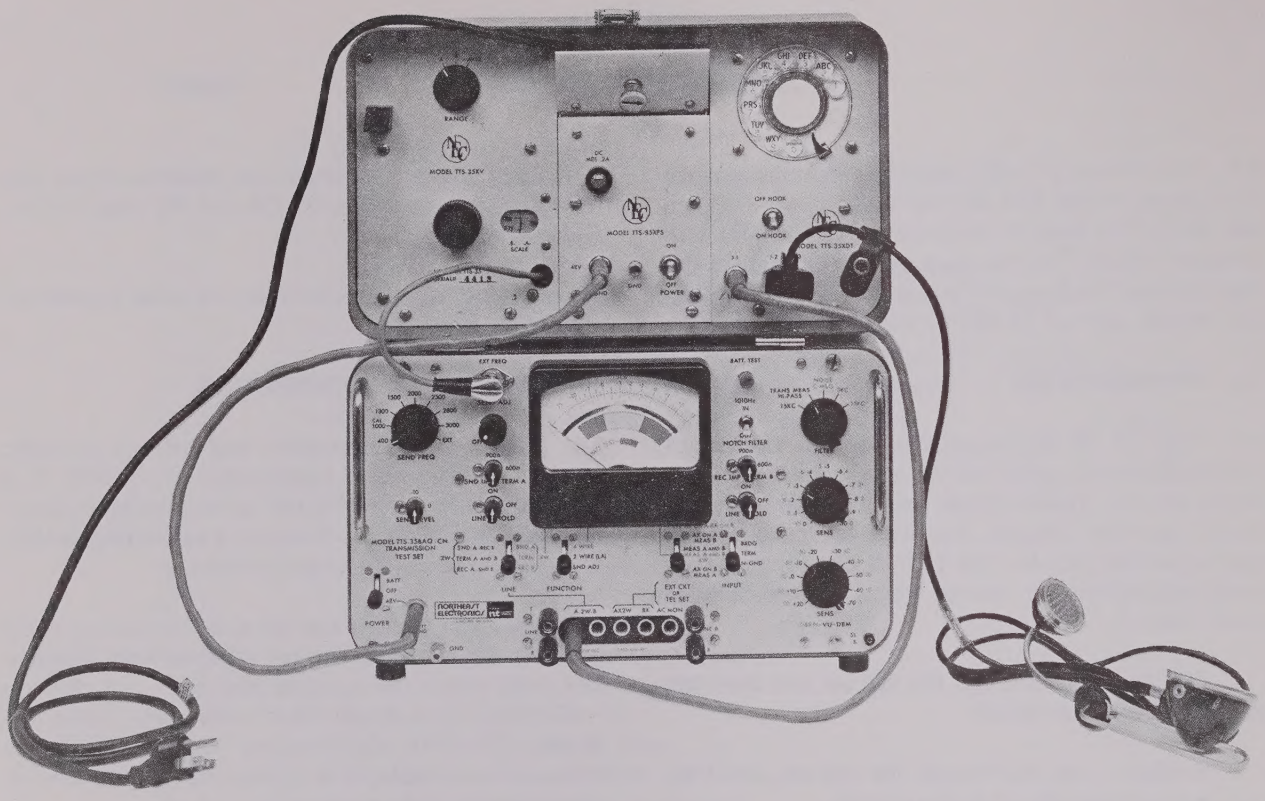


Figure 1—1. Typical Test Set-Up With Portable Model And Cover Accessories

1.10 Selectable input filters are provided to: (1) attenuate low frequency energy near 60 Hz, (2) attenuate high frequency energy above the voice band, or (3) provide C-message weighting. The filter switch is used to select (1) the appropriate filter network for level or noise measurement, and (2) either an average detector for level measurement or a quasi-rms detector for noise measurement. The detectors drive the VU-DB meter.

1.11 A 1010-Hz notch filter may be inserted into the receive circuit using a two-position toggle switch. The notch filter is normally used in the receive C-MSG, 3KC or 15KC blue positions associated with noise measurements. If the notch filter is used in any of the tone level positions, the receive section is intentionally inhibited.

1.12 The input to the TTS-35 is ac coupled and balanced. Selection of a quiet termination of 600 or 900 ohms plus 2 microfarads is provided as well as standard terminations of 600 or 900 ohms or 15,000 ohms in the bridged mode. For noise-to-ground measurements, the input is terminated through a precision resistor to ground.

1.13 Connections to the send and receive sections are made with standard 310-type telephone jacks or binding posts located on the front panel. Switchable hold coils are provided for the two LINE input jacks labeled A and B.

1.14 The TTS-35 may be operated from 12 internal 1.5-volt D cells (18 volts) or from a 48-volt central office battery. The battery voltage is regulated to 18 volts and 12 volts by the TTS-35. Reverse polarity protection is provided for CO battery inputs supplied to the front panel input power jack. With intermittent use, internal battery life is approximately 130 hours.

1.15 OPTIONAL ACCESSORIES

1.16 Three optional cover accessories are available for use with the TTS-35. They are completely independent and may be installed separately.

1.17 TTS-35XDT DIAL AND TALK ADAPTER

1.18 This is an optional cover accessory for the TTS-35 that provides a convenient means to dial, talk and listen on a subscriber line being tested. A standard type 52A headset plugs into the TTS-35XDT.

1.19 TTS-35XPS AC POWER SUPPLY ADAPTER

1.20 This adapter converts 110 Vac to 48 Vdc. It allows the TTS-35 to be operated from commercial power sources, without internal batteries or access to a central office battery.

1.21 TTS-35XV CONTINOUSLY VARIABLE FREQUENCY ADAPTER

1.22 The TTS-35XV extends the TTS-35 output signal frequency range to between 200 Hz and 7000 Hz with the same adjustable output levels as are provided in the basic test set.

1.23 **PHYSICAL DESCRIPTION**

1.24 The portable TTS-35 consists of a case assembly and a cover assembly. The two assemblies are hinged together and are provided with a latch and carrying handle. The assemblies may be separated during operation, if desired.

1.25 Two different cover assemblies are available. The standard cover has a storage compartment for test cords inside the lid. An optional deep cover houses up to three cover accessories as described in paragraph 1.15.

1.26 The case assembly contains the electronics and the front panel with its switches, jacks and meter. The following ten assemblies are located within the case.

1. Recieve Amplifier 1	PC1
2. Receive Amplifier 2	PC2
3. Oscillator Board Assembly	PC3
4. QRMS Detector Assembly	PC4
5. 1010-Hz Notch Filter Assembly	PC5
6. Input Impedance Board	CB1
7. Quiet Termination Assembly	CB2
8. Voltage Divider Assembly	CB3
9. Capacitor Assembly	C161
10. Jack Block Assembly	MP1

1.27 The assemblies are mounted to aluminum brackets and are attached to the front panel. Refer to Figure 7—2 in Section 7 for an exploded view of the TTS-35. This diagram locates and identifies the majority of the parts and assemblies.

1.28 The rack-mount model is functionally identical to the portable model, except it must be operated from a 48-volt power source. (Internal battery operation is not provided.) The standard rack model is for 19" rack installations. A 23-inch rack-mount version is available on special order. Both rack-mount models occupy 8¾" of height in the rack.

SECTION 2

SPECIFICATIONS

2.1 This section tabulates the electrical, mechanical, and performance specifications for the TTS-35 and its standard cover accessories. Table 2—1 covers the TTS-35. Tables 2—2 through 2—4 cover the accessories.

Table 2—1. TTS-35 Specifications

ELECTRICAL SPECIFICATIONS	
Input Power	
48 Volt Operation:	Uses CO battery source. Current drain is approximately 84 mA.
Internal Battery Operation: (130 hours of intermittent use)	Uses twelve, 1.5-volt D cells located in bottom of case assembly.
Overload Protection:	CO battery input protected with 1/10 amp fuse (internal).
Reverse Voltage Protection:	CO battery input has diode protector.
Line Jacks A & B:	Switchable hold coils and dc blocking provided.
MECHANICAL SPECIFICATIONS	
Weight:	19.5 lb (8.85 kg)
Dimensions	
Case Assembly:	14″ w x 6¾″ h x 8″ d (35.6 x 17.1 x 20.3 cm)
Standard Cover:	14″ w x 6¾″ h x 3¾″ d (35.6 x 17.1 x 9.5 cm)
Deep Cover (optional):	14″ w x 6¾″ h x 8″ d (same as case assembly)
SEND SECTION PERFORMANCE SPECIFICATIONS	
Output Frequencies:	300, 400, 500, 1000, 2300, 2500, 2800, 3000, 3100, and 3200 Hz.
Frequency Accuracy:	2% from 50°F to 100°F (10°C to 38°C).
Output Distortion:	Less than 1% at any harmonic.
Output Level:	Calibrated by SEND ADJ control between −40 and +3 dBm.
Output Level Variation:	Maximum level change ±0.2 dB when switching frequencies.

Table 2—1. (cont'd)

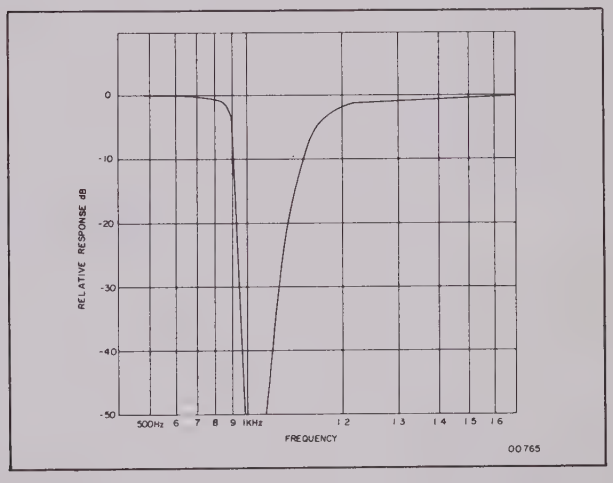
Output Impedance:	Switch selectable for 600 or 900 ohms.

RECEIVE SECTION PERFORMANCE SPECIFICATIONS

Input Impedances	
Coupling:	Balanced transformer.
Terminations:	Switch selectable for 600 or 900 ohms ±5% with a phase angle of less than 5° when hold coil is out.
Bridged:	15 kohms.
Longitudinal Drain:	85 kohms across line; 100 kohms to ground.
Overall Measurement Range	
Tone Level:	+23 to −95 dBm.
Noise:	+113 to −5 dBrn.
Noise-To-Ground:	+153 to +35 dBrn (actual measurement is 40 dB higher than indicated on meter).
Meter Calibration	
Tone Level Scale:	+3 to −15 dB.
Noise Scale:	+13 to −5 dBrn.
Scale Factors:	Refer to Figure 4—3.
Tracking Accuracy:	±0.15 dB from +3 dB to −3 dB.
Scale Colors:	Black for VU and dB. Blue for noise (dBrn). Red, yellow and blue arcs for VU approximations. Green arc marked GOOD for battery test.
Accuracy	
Overall Measurement:	At room temperature with good batteries ±0.2 dB at 1 kHz.
Attenuators:	±0.15 dB.
Temperature:	With respect to measurements at +77°F (+25°C), ±0.15 dB maximum from 32°F to 122°F (0°C to 50°C).
Battery Voltage Error:	With voltage indicating within green arc marked GOOD on meter BATT TEST scale, ±0.1 dB error maximum.

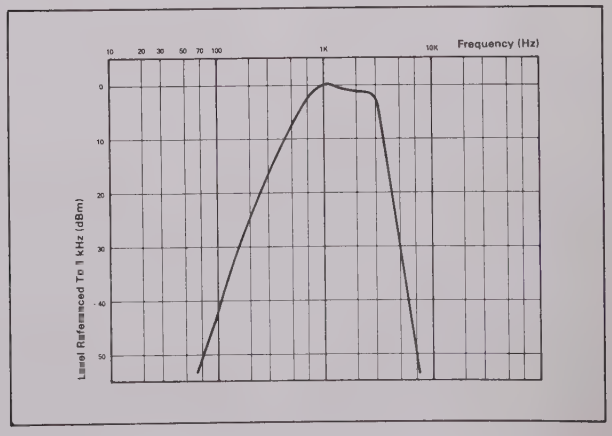
Table 2—1. (cont'd)

Monitor Output	
Output Impedance:	600 ohms.
Output Level:	−10 dBm ± 1 dB when meter indicates 0 dB.
Maximum Undistorted Output Level:	−2 dBm.
Filter Frequency Response	
1010-Hz Notch Filter:	±0.5 dB from 100 to 400 Hz and 1.7 to 10 kHz. ±3.0 dB from 400 to 863 Hz and 1.182 to 1.7 kHz. Equal to or greater than 50 dB from 995 to 1025 Hz (+5 dB maximum input level).



1010 Hz Notch Filter Frequency Response Curve

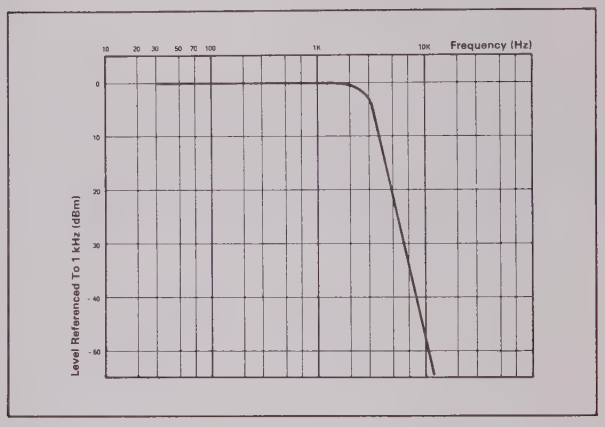
C-Message Filter:	Normalized for zero insertion loss at 1 kHz.



C-Message Filter Frequency Response

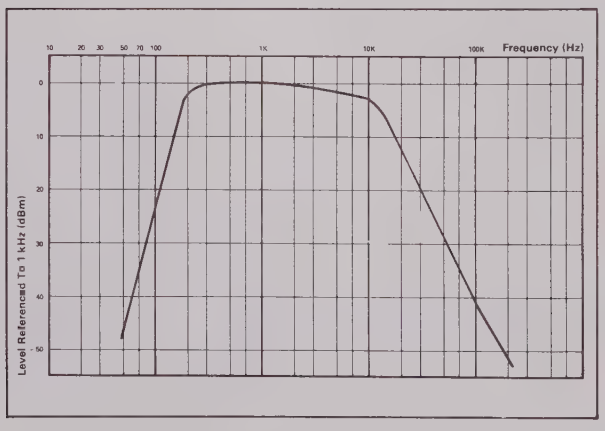
Table 2—1. (cont'd)

3-kHz Filter:	±0.2 dB between 600 Hz and 2 kHz. −3 dB nominal at 3 kHz. HF slopes −18 dB per octave above cutoff.



3-kHz Flat Filter Frequency Response

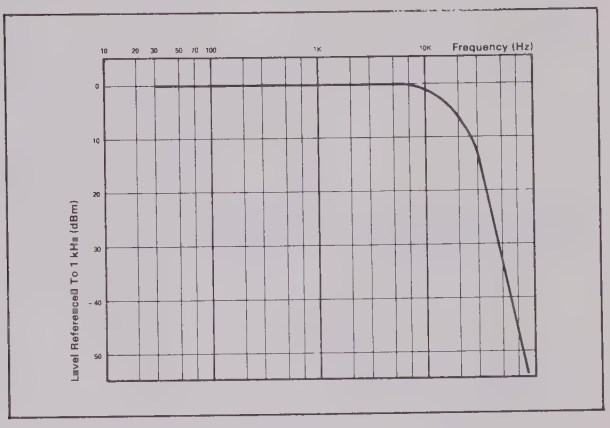
High-Pass Filter:	±1 dB between 300 Hz and 5 kHz. −3 dB nominal at 475 Hz and 15 kHz. −4 dB at 180 Hz. Equal to or greater than −25 dB at 60 Hz.



High-Pass Filter Frequency Response

Table 2—1. (cont'd)

15-kHz Filter:	±0.2 dB between 100 Hz and 5 kHz. −3 dB nominal at 15 kHz. HF slopes −18 dB per octave above cutoff.



15 kHz Flat Filter Frequency Response

Table 2—2. TTS-35XDT Specifications

ELECTRICAL SPECIFICATIONS

Dial And Voice Circuit:	Standard telephone type.

MECHANICAL SPECIFICATIONS

Dimensions:	4½" w x 8" h x 4½" d (11.4 x 20.3 x 11.4 cm).
Weight:	3 lb (1.4 kg).

Table 2—3. TTS-35XPS Specifications

ELECTRICAL SPECIFICATIONS

Voltages	
Input:	115 Vac with 0.5 amp maximum.
Output:	48 Vdc with 0.2 amp maximum.
Regulation	
No Load Output:	70 ± 6 Vdc, ripple ≦ 1 v p-p.
Full Load Output:	45 ± 3 Vdc, ripple ≦ 1 v p-p.
Maximum Load Current:	200 milliamps.

Table 2—3. (cont'd)

MECHANICAL SPECIFICATIONS

Dimensions:	4″ w x 8″ h x 4½″ d (10.1 x 20.3 x 11.4 cm).
Weight:	4 lb (1.8 kg).

Table 2—4. TTS-35XV Specifications

ELECTRICAL SPECIFICATIONS

Frequency Ranges:	A = 200 to 700 Hz. B = 600 to 2100 Hz. A x 10 = 2000 to 7000 Hz.
Frequency Accuracy:	±3% of scale when TTS-35XV and TTS-35 are calibrated together.
Output Level:	±0.3 dB constant throughout frequency ranges.

MECHANICAL SPECIFICATIONS

Dimensions:	5¼″ w x 8″ h x 4½″ d (12.3 x 20.3 x 11.4 cm).
Weight:	3.5 lb (1.6 kg).

SECTION 3

INSTALLATION

3.1 This section provides information needed to install a TTS-35 Series test set.

3.2 VISUAL INSPECTION

3.3 After unpacking the test set, visually check the exterior for any damage received during shipment. Notify the common carrier if damage is found.

CAUTION

Do not attempt to operate the TTS-35 if damage is apparent.

3.4 SERVICE INFORMATION

3.5 Generally, each instrument manufactured by Northeast Electronics is warranteed for a period of one year from date of delivery to the original purchaser. Complete warranty information is contained in the purchase order agreement under Terms and Conditions of Sale. Written authorization is required prior to the return of any equipment for factory repairs. Additional service information may be obtained by contacting Northeast Electronics, Customer Service Department, P.O. Box 649, Concord, New Hampshire, 03301, telephone number 603-224-6511.

3.6 LOCATION CONSIDERATIONS

3.7 Portable models may be located anywhere. Rack-mount models must be located where there is access to CO battery and ground.

3.8 MOUNTING PROCEDURE

3.9 The portable models should be operated with the front panel meter in the **face up** position for optimum accuracy. The test set is calibrated in this position. In order to guarantee ± 0.1 dB accuracy between $+1$ dB and -1 dB on the meter scale, the test set must be placed in the same position in which it was calibrated. If it is to be operated with the panel in the vertical position, the receive circuits should be re-calibrated.

3.10 The rack-mount models have a special front panel with cut-outs for mounting in a 19-inch rack. Figure 3—1 illustrates the mounting arrangement. Note that CO battery and ground may be applied to the front panel 310 power jack or to a separate terminal strip on the backside of the front panel. The -48 volt input is applied to the bottom terminal and ground is applied to the next terminal. The remaining four terminals are not used. The TTS-35R cannot be used with internal batteries.

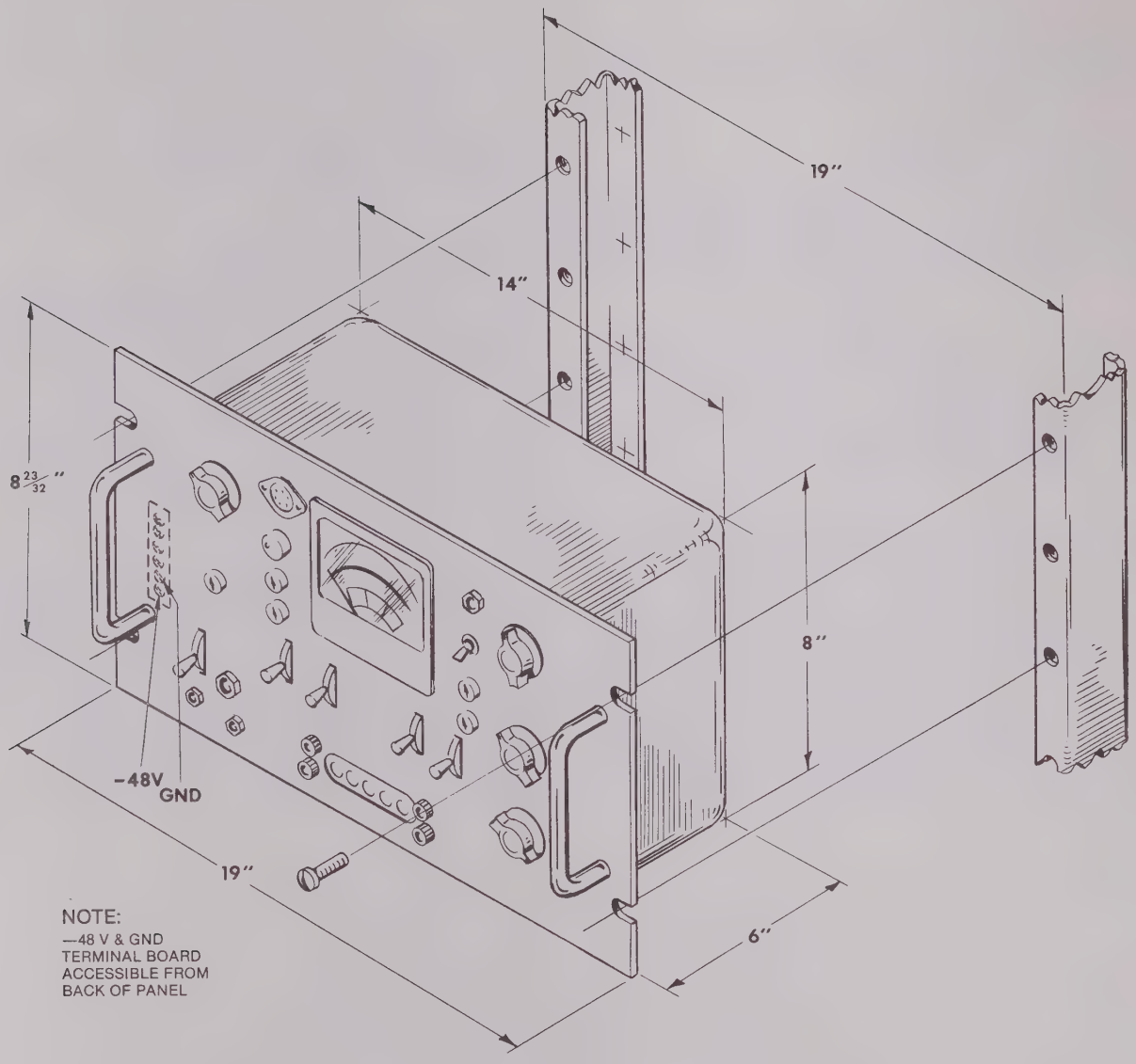


Figure 3—1. Rack Mounting (TTS-35R)

SECTION 4

OPERATION

4.1 This section provides information needed to operate the TTS-35 Series test sets. The information includes: (1) descriptions of all controls and indicators for the test set and cover accessories, (2) preliminary operating procedures, (3) general operating instructions for 2-wire and 4-wire circuits, (4) specific measurement procedures for typical applications, and (5) operating procedures for the cover accessories.

4.2 CONTROLS AND INDICATORS

4.3 Operator controls and indicators are divided into three functional groups as follows:

1. Power and Switching Section
2. Send Section
3. Receive Section

Figures 4—1 through 4—3 locate the controls. Tables 4—1 through 4—3 describe their functions.

4.4 Cover accessories for the TTS-35 consist of the following items:

1. TTS-35XV Continuously Variable Frequency Adapter
2. TTS-35XPS AC Power Supply Adapter
3. TTS-35XDT Dial and Talk Adapter

Figures 4—4 through 4—6 locate the accessory controls. Tables 4—4 through 4—6 describe their functions.

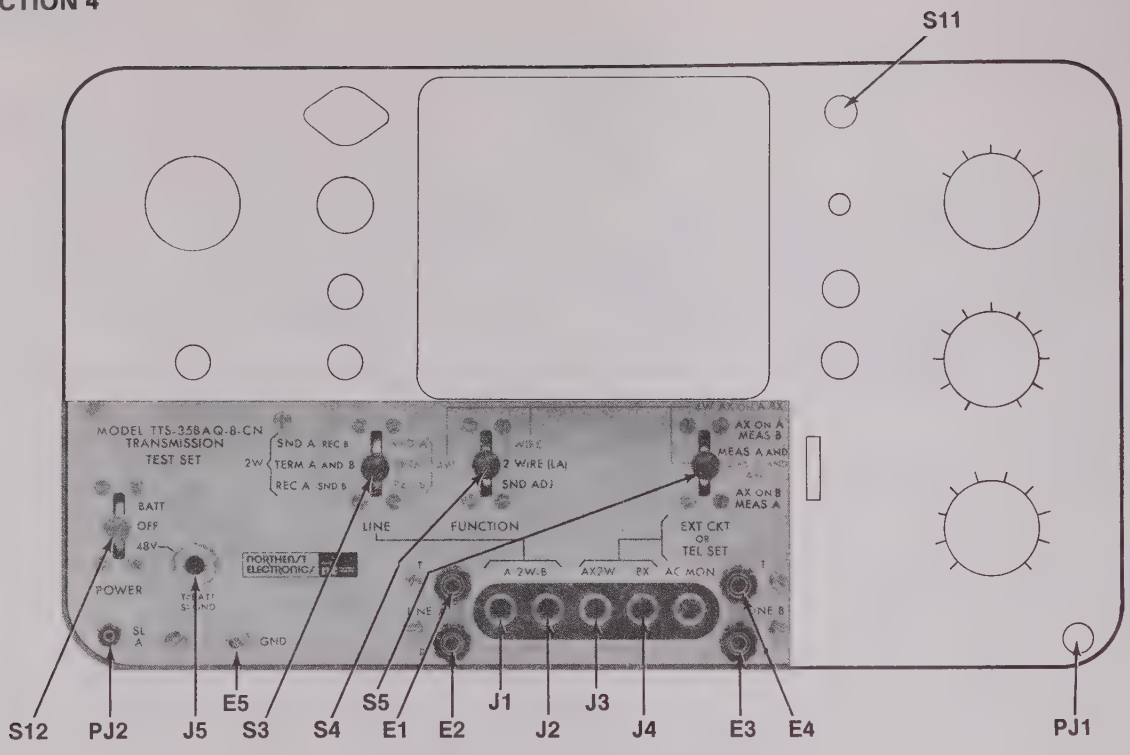


Figure 4—1. Power And Switching Sections Controls And Indicators

Table 4—1. TTS-35 Controls And Indicators (Send Section)

REFERENCE DESIGNATOR	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
POWER SECTION		
J5	T = BATT S = GND jack	310 type jack for connecting external 48 volt power.
S11	BATT. TEST switch	Connects −18 volts used for receive section to meter M1 for testing batteries or external power.
S12	POWER switch	Controls application of dc power from an internal source (batteries) or an external source (−48 volts).
SWITCHING SECTION		
E1 & E2	LINE A T and R binding posts	Provides a parallel connection to LINE A jack J1.
E3 & E4	LINE B T and R binding posts	Provides a parallel connection to LINE B jack J2.
E5	GND binding post	Provides chassis ground connection for use in noise-to-ground measurements.

Table 4—1. (cont'd)

REFERENCE DESIGNATOR	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
J1	LINE A 2-W jack or SEND 4-W jack	Provides input/output 310 jack connection for one 2-wire circuit or the send branch of a 4-wire circuit.
J2	LINE B 2-W jack or REC 4-W jack	Provides input/output 310 jack connection for a second 2-wire circuit or the receive leg of a 4-wire circuit.
J3	LINE AX 2-W jack or SND 4-W jack	Provides auxiliary input/output 310 jack connection for one line A 2-wire circuit or the send branch of a 4-wire circuit. Normally used with an external circuit (EXT CKT) or telephone set (TEL SET).
J4	LINE BX 2-W jack or REC 4-W jack	Same as J3 except for LINE B auxiliary connections or the receive branch of a 4-wire circuit. Normally used with an external circuit (EXT CKT) or telephone (TEL SET).
PJ1	SL B pin jack	Provides connection to sleeve of LINE B jack J2. For control use on sleeve-supervised circuits.
PJ2	SL A pin jack	Provides connection to sleeve of LINE A jack J1. For control use on sleeve-supervised circuits.
S3	LINE switch	Controls activity on both LINE A and LINE B during 2 and 4 wire measurements when S5 is in MEAS A AND B position. In other two positions of S5, it controls activity of either LINE A, or LINE B depending on position of S5.
S4	FUNCTION switch	Enables blue functions of S3 and S5 in 4-WIRE position and black functions in 2-WIRE (LA) position. SND ADJ position allows output level to be set using meter M1 and SND ADJ R101/S13.
S5	EXT CKT OR TEL SET switch	In the up or down position, controls connection of AX and BX jacks J1 and J2 and Line A or B inputs to measurement circuits. In center position, measurements and connections are controlled by LINE switch S3.

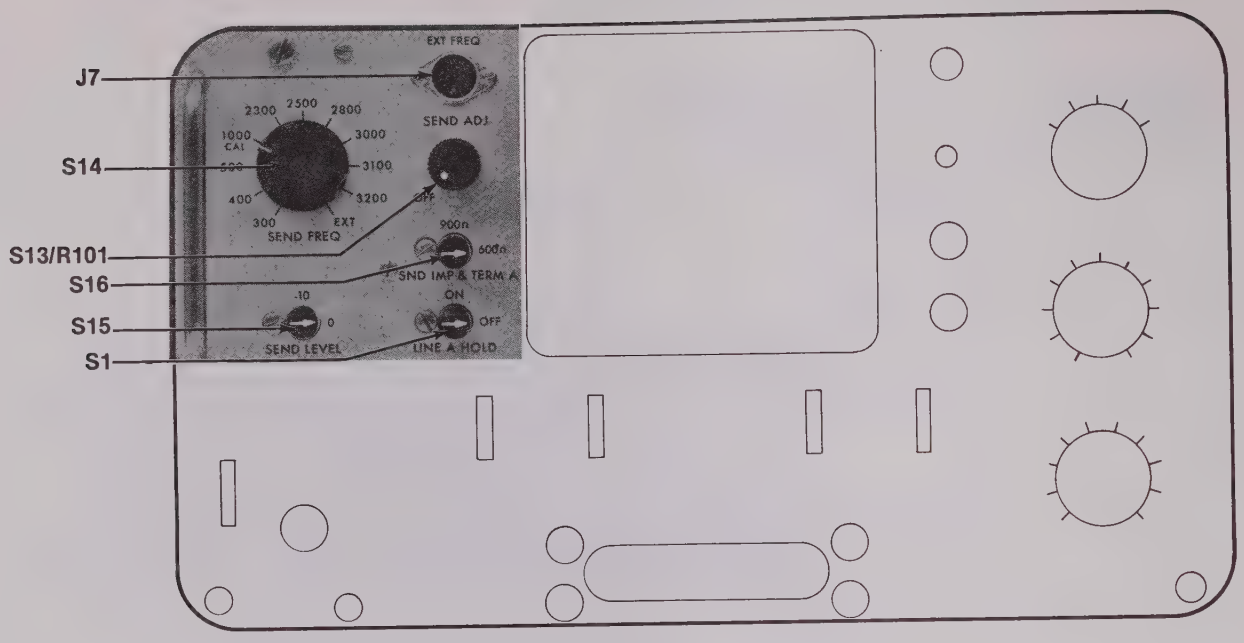


Figure 4—2. Send Section Controls And Indicators

Table 4—2. TTS-35 Series Controls And Indicators (Send Section)

REFERENCE DESIGNATOR	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
SEND SECTION		
J7	EXT FREQ connector	Provides connection for TTS-35XV Continuously Variable Frequency Adapter.
S1	LINE A HOLD switch	Connects hold coil L1 across LINE A jack J1.
S13/R101	SEND ADJ switch/pot	Conserves battery power by allowing send section to be turned off when not in use. Potentiometer sets output power level on meter M1. FILTER switch S9 must be in one of the two 15KC positions to enable SEND ADJ.
S14	SEND FREQ switch	Selects one of ten fixed frequencies to be transmitted or allows TTS-35XV Continuously Variable Frequency Adapter to supply tone in EXT position via EXT FREQ connector J7.
S15	SEND LEVEL switch	Inserts 0 or 10 dB attenuation in send level output.
S16	SND IMP & TERM A switch	Selects either 600 or 900 ohm impedance and adjusts quiet termination for LINE A to selected impedance.

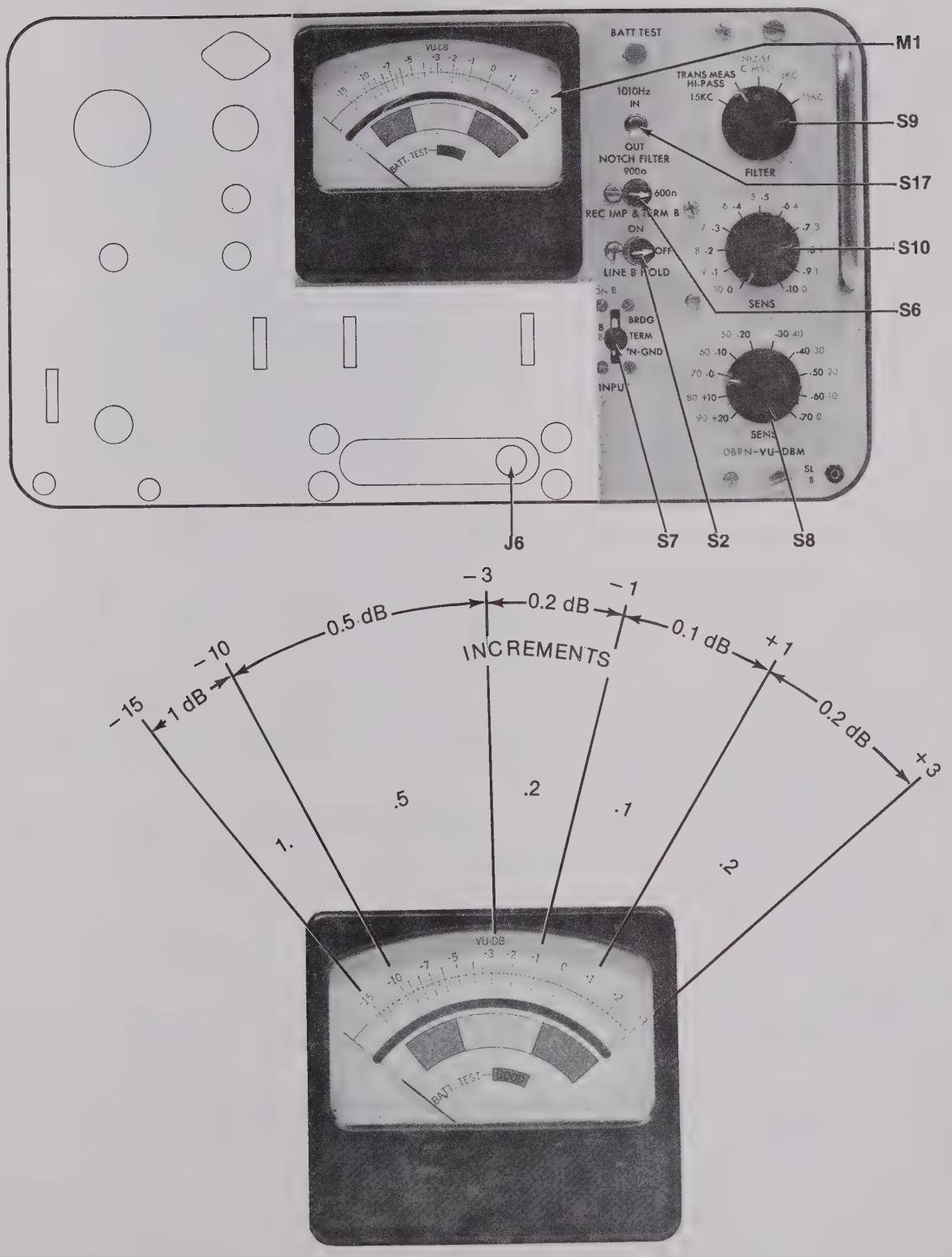


Figure 4—3. Receive Section Controls And Indicators

Table 4—3. TTS-35 Series Controls And Indicators (Receive Section)

REFERENCE DESIGNATOR	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
RECEIVE SECTION		
J6	AC MON jack	Allows received tone or noise to be heard with a headset or monitored with other external equipment while simultaneously being measured on meter M1. If an external dc voltage is applied to the tip of AC MON jack J6, it should not exceed −9 volts or +12 volts.
M1	VU-DB meter	Shows value of level, noise, or VU being measured. M1 functions as a voltmeter when BATT TEST switch S11 is pressed to indicate the condition of the −18 volt supply.
S2	LINE B HOLD switch	Connects hold coil L2 across LINE B jack J2.
S6	REC IMP & TERM B switch	Selects either 600 or 900 ohms input impedance and adjusts quiet termination for LINE B to selected impedance.
S7	INPUT switch	Selects appropriate input impedance network for receive measurements which (1) bridge the input line (BRDG), (2) are terminated by a 600 or 900 ohm quiet termination (TERM) or (3) for noise-to-ground measure ments (N-GND).
S8	SENS (DBRN-VU-DBM) switch	Controls range of measurements indicated by meter M1. May be set in 10 dB increments from −70 to +20 dB.
S9	FILTER switch	Provides selection of one of two input filters for level measurements (15KC and HI-PASS) or one of three for noise measurements (C-MSG, 3KC and 15KC). Also enables an average detector for level measurements or a quasi rms detector for noise measurements.
S10	SENS switch	Increases measurement range indicated on meter M1 up to 10 dB by removing attenuation in 1 dB steps.
S17	NOTCH FILTER switch	Switches a 1010-Hz C-notch filter into receive circuits front end for making noise-with-tone measurements. Receive circuits are intentionally inhibited if notch filter is IN and FILTER switch S9 is not in one of the three blue positions used for noise measurements.

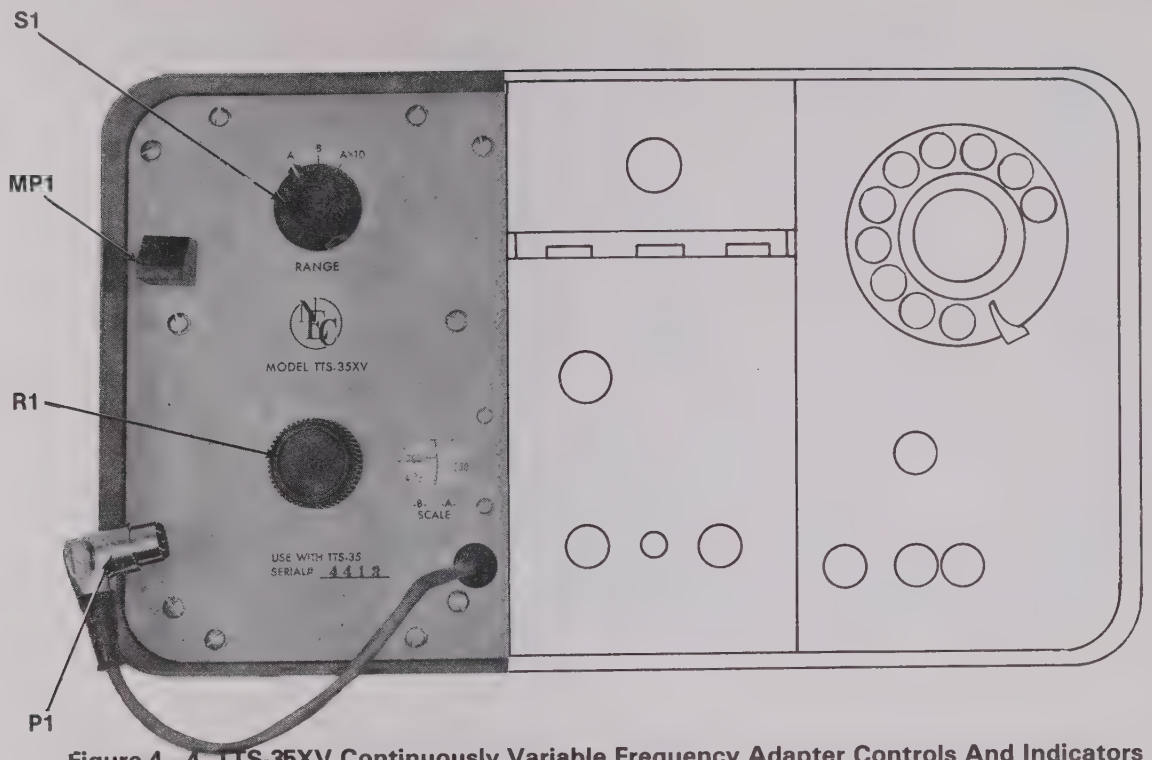


Figure 4—4. TTS-35XV Continuously Variable Frequency Adapter Controls And Indicators

Table 4—4. TTS-35XV Continuously Variable Frequency Adapter Controls And Indicators

REFERENCE DESIGNATOR	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
MP1	Wooden block	Conserves TTS-35 internal batteries by forcing POWER switch OFF when cover is closed.
P1	5-pin connector and cord	Provides connection from TTS-35XV to EXT FREQ jack J7 on TTS-35.
R1	—B— —A— SCALE potentiometer	Provides tuning desired send frequency within selected range.
S1	RANGE switch	Selects range A, B, or A X 10 to obtain desired send frequency from TTS-35. A = 200-700 Hz, B = 600-2100 Hz, A x 10 = 2000-7000 Hz.

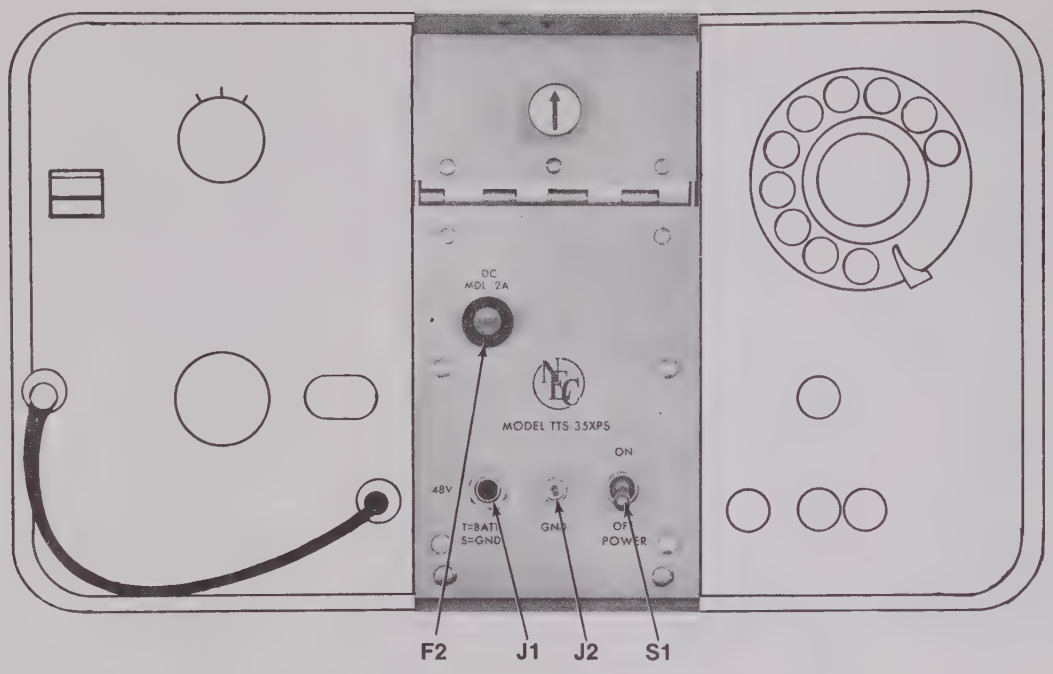


Figure 4—5. TTS-35XPS AC Power Supply Adapter Controls And Indicators

Table 4—5. TTS-35XPS AC Power Supply Adapter Controls And Indicators

REFERENCE DESIGNATOR	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
F1	0.5 amp fuse (internal)	Output overload protection.
F2	DC MDL 0.2 amp fuse	Input overload protection.
J1	48V jack T = BATT S = GND	Provides external dc power connection to TTS-35 via 310 cord.
J2	GND binding post	Provides chassis ground connection.
S1	POWER switch	Controls application of AC input power.

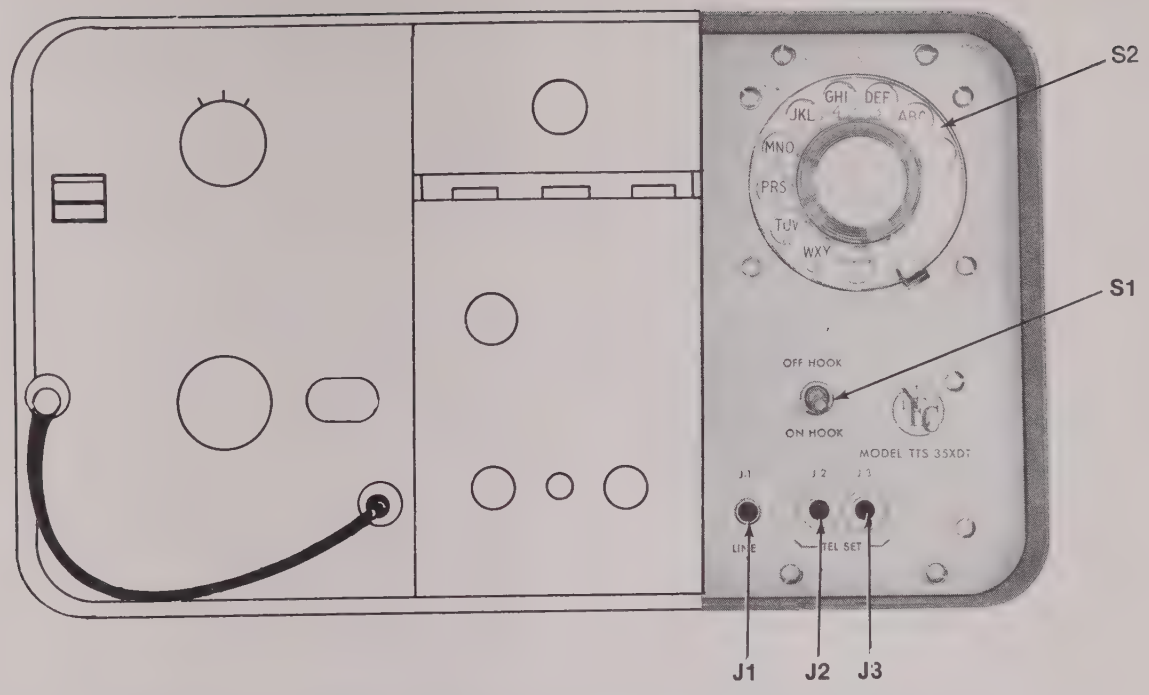


Figure 4—6. TTS-35XDT Dial And Talk Adapter Controls And Indicators

Table 4—6. TTS-35XDT Dial And Talk Adapter Controls And Indicators

REFERENCE DESIGNATOR	CONTROL, INDICATOR OR CONNECTOR	FUNCTION
J1	LINE jack	Provides connection from LINE jack of TTS-35 to TTS-35XDT.
J2, J3	TEL SET jacks	Provides connections for 52A type external telephone set to TTS-35 to talk and monitor on a line. Telephone transmitter connects to J2 and receiver connects to J3.
S1	OFF HOOK-ON HOOK switch	Seizes line patched from TTS-35 in off-hook position.
S2	Telephone Dial	Provides dialing capability on line patched to TTS-35.

4.5 **PRELIMINARY OPERATING PROCEDURES**

4.6 INPUT POWER

4.7 Power for the portable test set and its cover accessories may be obtained from one of three sources as follows:

1. Internal D-size dry cells (twelve cells at 1.5 volts each equals 18 volts.).

2. Normal CO battery and ground (−48 volts is regulated to −18 volts by the test set).

3. TTS-35XPS cover accessory operates from 110 Vac. Its −48 volt output is used in place of CO battery and ground for the portable test set only.

NOTE

Rack-mount models have no internal batteries. They require −48 Vdc from an external source.

4.8 POWER switch S12 is used to select either the internal BATT source or the 48V source connected to input jack J5. When the test set cover (either the standard cover or the deep cover with accessories) is closed,

a special wooden block inside the cover strikes POWER switch S12 if it is in the BATT position. This forces the switch to the OFF position.

4.9 If 48-volt input power is used, the 310 plug inserted into jack J5 prevents the cover from closing completely. When the plug is removed the cover may be closed. Thus, for either situation, power is removed whenever the cover is completely closed and latched.

4.10 METER NEEDLE MECHANICAL ZERO

4.11 Before applying power, check meter needle for full left deflection with the test set in its normal orientation (meter face up for portable models, vertical for rack-mount models). Use the parallax-correcting mirrored face on the meter to accurately determine needle position.

4.12 Align eyes with needle until the needle reflection is **not** visible, then observe needle position with respect to the leftmost mark on meter scale. If necessary, adjust mechanical zero screw in lower center of meter in order to position the needle on the leftmost mark. This insures accurate readings within the ±0.1 dB capability of the test set.

4.13 BATTERY TEST

4.14 After checking meter needle alignment, apply power to the test set (either BATT or 48V) and hold BATT TEST switch S11 pressed. Needle should deflect to the right and fall within the green portion of the arc on the bottom scale marked BATT. TEST-GOOD. Do not use the red-yellow-green arcs on the middle scale. These are for volume unit measurements (VU). This procedure checks the condition of the internal batteries or the 48 volt source as appropriate. Return POWER switch S12 to the OFF position. If the batteries need to be replaced, refer to procedure in paragraph 6.2.

4.15 TEST PLUGS

4.16 Depending on the test to be performed, several different types of plugs may be used. Figure 4—7 illustrates them and shows where they are used on the test set. The various types are listed in Table 4—7.

4.17 Except for the power cord and the cords from a telephone set to a TTS-35XDT accessory, the test cords should have 2 or 3 conductors for connection to the tip and ring leads of the circuit being tested. Each cord should have a 310 type plug on the test set end.

4.18 When testing 4-wire circuits, the connections to the send and receive branches require a 4 or 6 conductor cord with a 425 double plug on the test set end. The 425 plug must be inserted into front panel jacks J3 and J4 so that the SND side connects to J3 (left) and the REC side connects to J4 (right) of the pair of jacks labeled SND-4W-REC.

4.19 The power cord and the telephone set cords should have 310 type plugs on the test set end using tip and sleeve conductors.

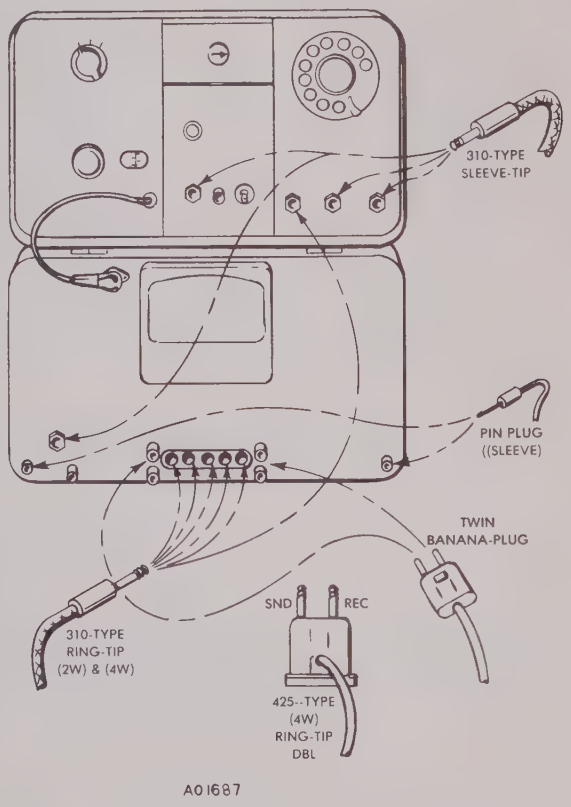


Figure 4—7. Test Plug Locations vs Types

Table 4—7. Test Plug Types

TYPE	USE
310 type	tip/ring
310 type	tip/sleeve
425 type (twin banana plug)	tip/ring-double
pin plug	sleeve

4.20 MEASURED POWER CALCULATIONS

4.21 Power levels for both send and receive are determined by algebraically combining the reading indicated on meter M1 with the two sensitivity switch settings on S8 and S10. (For send measurements, the setting of SEND LEVEL switch S15 must also be included . . . either 0 or −10 dB.) Three types of measurements may be made as shown in Table 4−8.

4.22 Example power calculations for send and receive for level and noise measurements are shown in Table 4−9. VU measurements are calculated in the same manner as level measurements. For noise-to-ground measurements, add 40 dBrn to the calculated measurement.

4.23 INPUT/OUTPUT JACK CONNECTIONS

4.24 Switches S3 (LINE), S4 (FUNCTION) and S5 (EXT CKT OR TEL SET) are used to select the required connections to the input/output jacks for 2-wire or 4-wire operation. Figure 4−8 shows the connections available with FUNCTION switch S4 in the 2-wire position and Figure 4−9 shows them for the 4-wire position of S4.

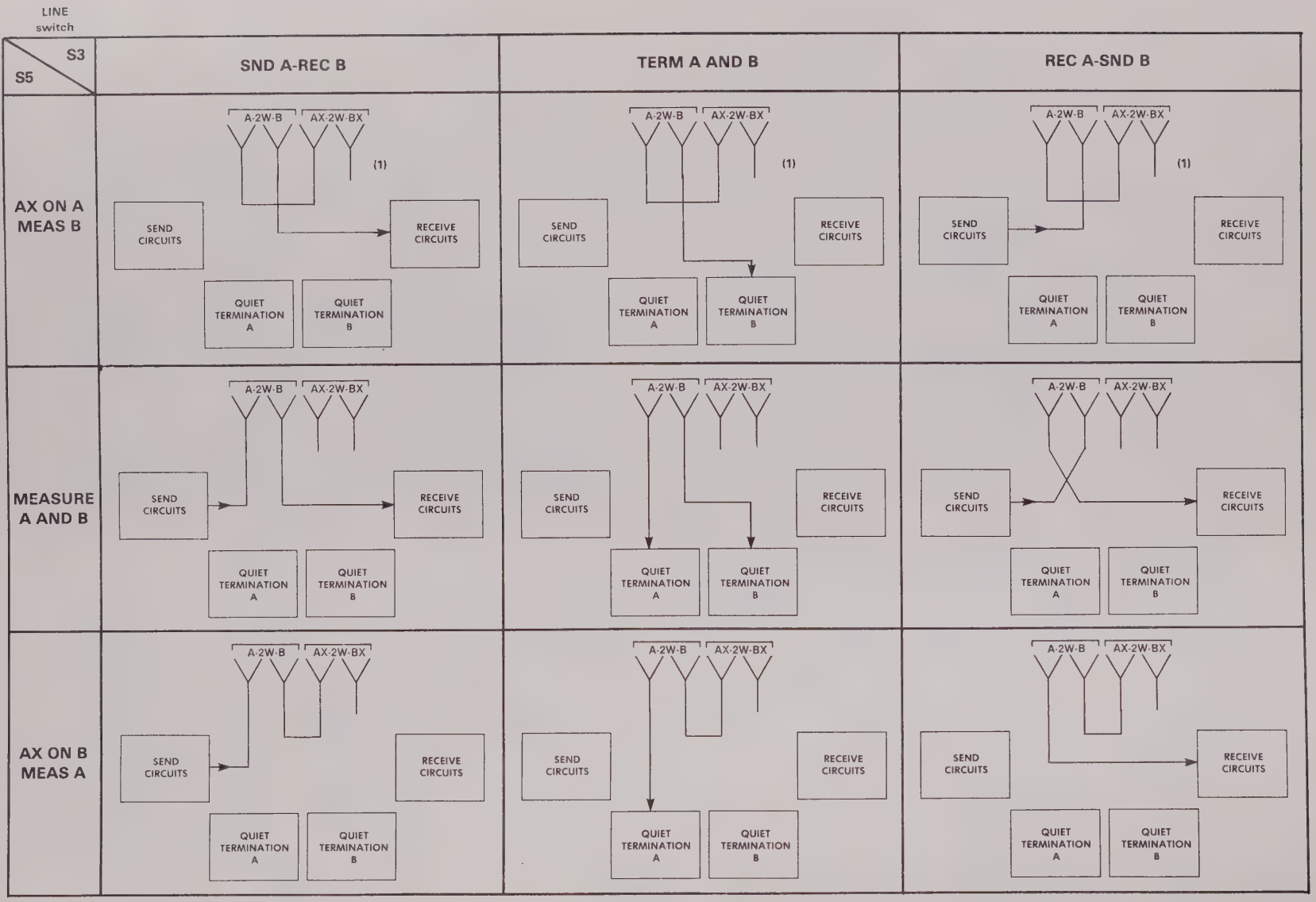
Table 4−8. Meter Scales

MEASUREMENT	SCALE	COLOR
LEVEL	−15 to +3 dBm	Black
NOISE	−5 to +13 dBrn	Blue
VU	−15 to −6 VU −6 to 0 VU 0 to +3 VU	Red Yellow Green

Table 4−9. Measured Power Calculation Examples

(NOTE 1) SEND LEVEL EXAMPLES (dBm)			
SENS switch S8	−10.0	+10.0	0.0
SENS switch S10	− 2.0	− 8.0	0.0
	−12.0	+ 2.0	0.0
SEND LEVEL switch S15	0.0	0.0	−10.0
	−12.0	+ 2.0	−10.0
(NOTE 2) Meter M1 Indication	− 0.3	+ 0.5	0.0
ACTUAL POWER	**−12.3**	**+ 2.5**	**−10.0**
RECEIVE TONE LEVEL EXAMPLES (dBm)			
SENS switch S8	+10.0	+20.0	−40.0
SENS switch S10	0.0	− 2.0	− 6.0
	+10.0	+18.0	−46.0
Meter M1 Indication	+ 1.0	− 3.0	+ 2.0
ACTUAL POWER	**+11.0**	**+15.0**	**−44.0**
RECEIVE NOISE EXAMPLES (dBrn)			
SENS switch S8	+ 80.0	+20.0	0.0
SENS switch S10	0.0	+ 9.0	+ 5.0
	+ 80.0	+29.0	+ 5.0
Meter M1 Indication	− 0.5	+11.0	+ 7.0
ACTUAL POWER	**+ 79.5**	**+40.0**	**+12.0**
(For Noise-to-ground only)	+ 40.0	+40.0	+40.0
ACTUAL N-G POWER	**+119.5**	**+80.0**	**+52.0**

NOTES
(1) To determine circuit gain (+) or loss (−), subtract send level from receive level.
(2) Level set by SEND ADJ S13/R101.



(1) If 310 plug is connected to BX, it opens B connections.

Figure 4—8. Input/Output Jack Combinations (2-Wire Position of FUNCTION switch S4)

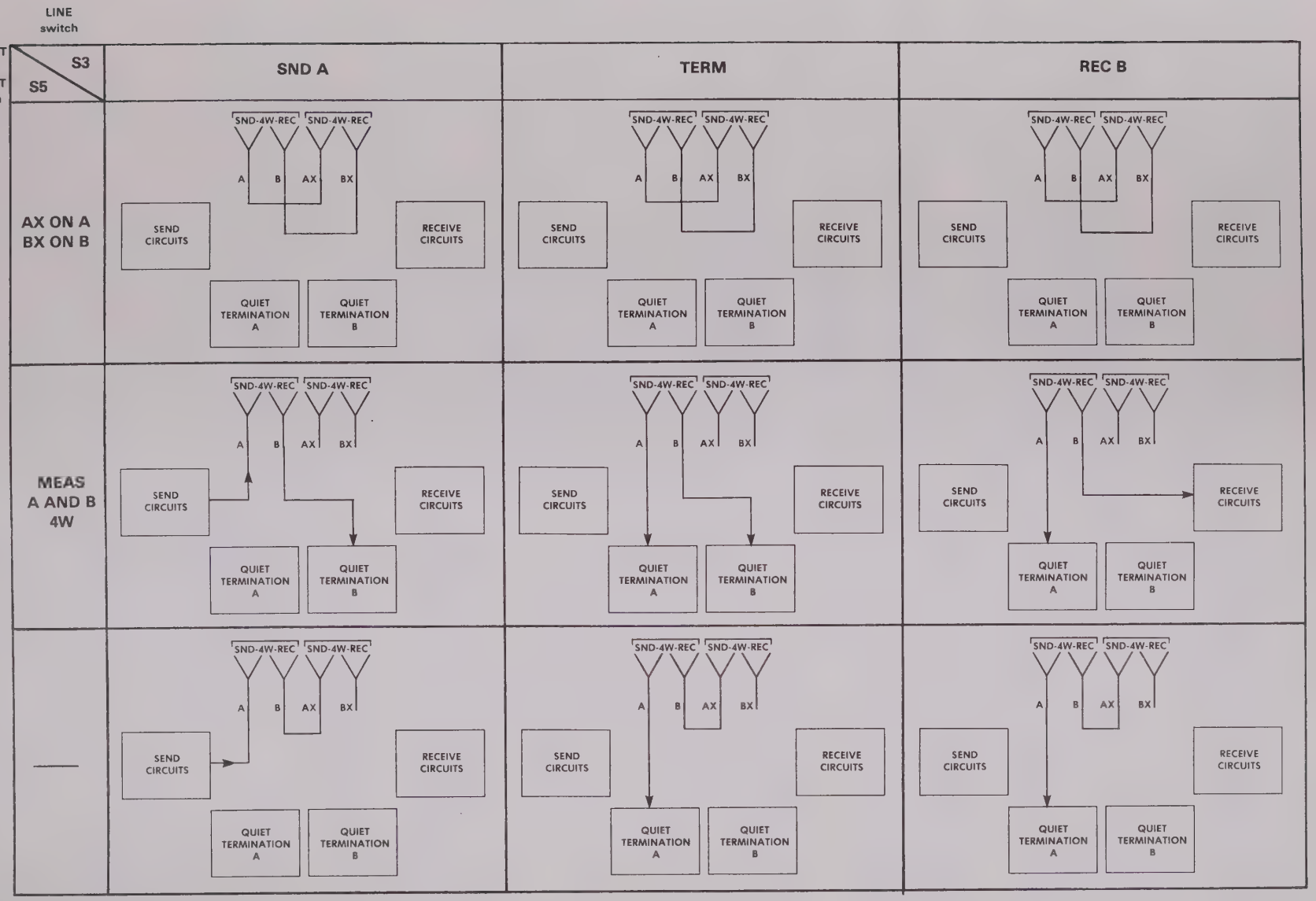


Figure 4—9. Input/Output Jack Combinations (4-Wire Position of FUNCTION switch S4)

4.25 Although the connections are shown separately for 2-wire and 4-wire circuits, any of the connections may be used with either type circuit. For example, with reference to Figure 4—8, in order to simultaneously send on A and receive on B on a 4-wire circuit, it is necessary to use the following switch combinations:

SWITCH	SETTING
S3	SND A-REC B
S4	2 WIRE (LA)
S5	MEASURE A AND B

4.26 In addition to the jack combinations shown in Figures 4—8 and 4—9, separate binding posts for tip and ring are wired in parallel with the 310 jacks for lines A and B. These connections and the sleeve A and B (SL A and SL B) pin jacks may be used whenever desired.

4.27 OPERATING INSTRUCTIONS

4.28 SUMMARY OF TESTS

4.29 The operating instructions which follow are divided into three broad categories as follows:

1. General Operating Instructions (2-wire and 4-wire)
2. Specific Measurement Procedures
3. Operation Of Cover Accessories

4.30 The general operating instructions are for common tests. They are presented in a tabular, step-by-step format for both 2-wire and 4-wire circuits. Table 4—10 summarizes the tests.

Table 4—10. General Operating Instructions Summary

PROCEDURE	TABLE NUMBER	
	2-WIRE	4-WIRE
1. Dial/Hold/Talk	4—13	4—18
2. Receive Measurements		
Tone Level	4—14	4—19
Noise	4—15	4—20
3. Send Section Operation	4—16	4—21
4. Quiet Termination Selection	4—17	4—22

4.31 Most specific measurement procedures are presented in narrative form with references as necessary to the general operating instructions in Table 4—10. The specific procedures are intended to show typical applications of the TTS-35 Series test sets. Other tests may be performed according to user needs.

4.32 Table 4—11 lists the specific measurement procedures. Note that they are divided into two types. One type is performed on an active circuit where the signal source is either the TTS-35 unit in a loop-around configuration . . . or another test set is used at the far end as the source. The second type involves using some of the common test lines at the far end of a circuit under test.

Table 4—11. Specific Measurement Procedures Summary

PROCEDURE	PARA. NUMBER
Circuit Test Applications	
1. Signal-to-noise ratio	4.38
2. Circuit Balance	4.44
3. Repeater/Amplifier Gain	4.48
4. Attenuation Distortion	4.52
Measurements To Common Test Lines	
1. Type 100-Balance Test Line	4.57
2. Type 102-Milliwatt Test Line	4.61
3. Type 103-Transmission Measuring and Noise Checking	4.66
4. Type 107-Data Transmission	4.73
5. TTS-52 or equivalent-loop around	4.78

4.33 Cover accessory procedures are summarized in Table 4—12.

Table 4—12. Cover Accessories Operating Procedures Summary

PROCEDURE	TABLE NUMBER
TTS-35XPS AC Power Supply Adapter	4—24
TTS-35XV Continuously Variable Frequency Adapter	4—25
TTS-35XDT Dial and Talk Adapter	4—26

4.34 HOW TO USE THE OPERATING INSTRUCTION TABLES

4.35 Tables 4—13 through 4—22 provide step-by-step operating instructions for testing 2-wire and 4-wire circuits. The tabular format illustrates positions of the test set controls and shows the set-up for the front panel jacks. The following points shoud be kept in mind.

1. Arrows are used to indicate the control positions.

2. If more than one position may be selected for a given test, the alternate positions are shown with dotted arrows.

3. Only switches that affect operation have arrows shown. Absence of an arrow means that the position of that control is immaterial.

4. Normally, the SEND ADJ control is left in the OFF position during receive measurements to minimize interference.

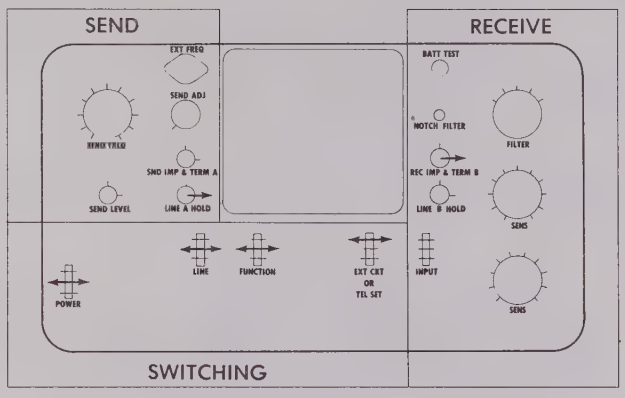
5. Procedures are shown for jacks A and B primarily. If desired, the paralleled tip and ring binding posts may be used. Also, jacks A and B may be swapped, or the AX and BX jacks may be used, as long as the proper switch combinations shown in Figures 4—8 and 4—9 are used.

NOTE

To obtain full rated accuracy, the test set must be used in the position for which it was calibrated . . . horizontal (meter up) for portable models . . . vertical for rack-mount models.

Table 4—13. Dial/Hold/Talk Procedure (2-Wire)

TEST SET-UP



SEND SECTION

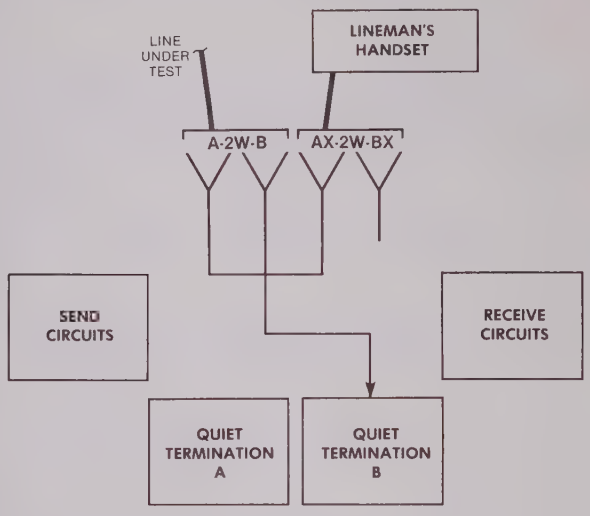
SEND FREQ. . . . . —
SEND ADJ. . . . . —
SEND LEVEL. . . . . —
SEND IMP & TERM A. . . . . —
LINE A HOLD . . . . . **OFF**

SWITCHING SECTION

POWER. . . . . **OFF**
LINE. . . . . **TERM A AND B**
FUNCTION. . . . . **2 WIRE (LA)**
EXT CKT OR TEL SET . . **AX ON A MEAS B**

RECEIVE SECTION

INPUT. . . . . —
LINE B HOLD. . . . . **OFF**
REC IMP & TERM B . . . . . —
NOTCH FILTER. . . . . —
FILTER . . . . . —
SENS . . . . . —
SENS . . . . . —



ACTION	RESULT
1. Position controls as shown above.	1. None
2. When line under test is not busy, patch lineman's handset to AX jack and line under test to A jack.	2. None
3. Use handset to go off hook.	3. Hear dial tone.
4. Dial number.	4. Hear dialing.
5. Talk to far end.	5. Hear conversation or test tone.
NOTE If a second call is to be placed while holding the first, continue with step 6.	
6. Place LINE A HOLD switch ON.	6. None
7. Patch second line under test to B jack.	7. None

Table 4—13. (cont'd)

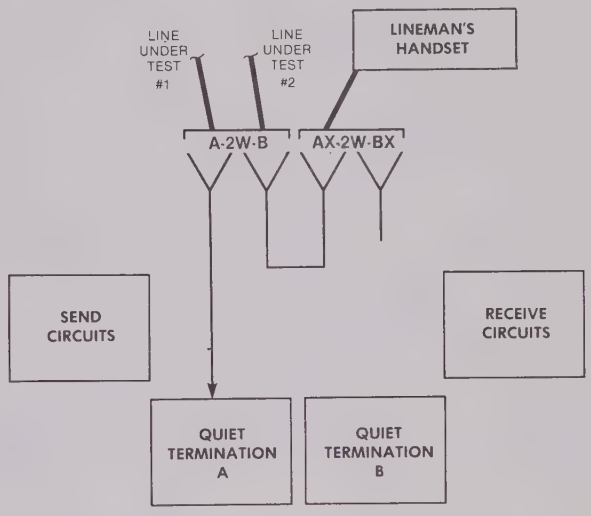
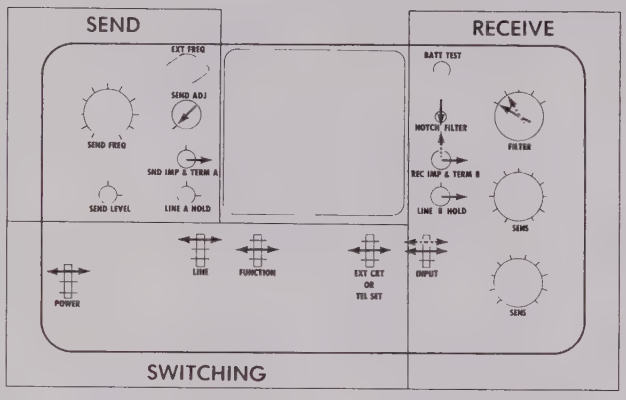
ACTION	RESULT
8. Place EXT CKT OR TEL SET switch to AX ON B MEAS A position.	8. New test set-up is shown below. 
9. Repeat steps 3 through 5 to dial and talk on second line. If desired, place LINE B HOLD switch ON.	9. Same as steps 3 through 5.
10. Conversation may be switched back and forth between lines 1 and 2 by changing position of EXT CKT OR TEL SET switch from AX ON B to AX ON A as required.	10. Hear conversation on selected line.

Table 4—14. Receive Tone Level Measurements (2-Wire)

TEST SET-UP



SEND SECTION

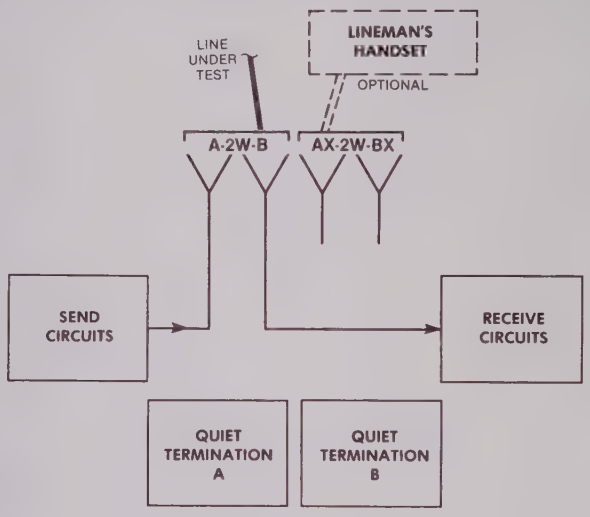
SEND FREQ ..... —
SEND ADJ ..... **OFF**
SEND LEVEL ..... —
SEND IMP & TERM A ..... —
LINE A HOLD ..... —

SWITCHING SECTION

POWER ..... **BATT**
LINE ..... **SND A-REC B**
FUNCTION ..... **2 WIRE (LA)**
EXT CKT OR TEL SET .... **MEAS A AND B**

RECEIVE SECTION

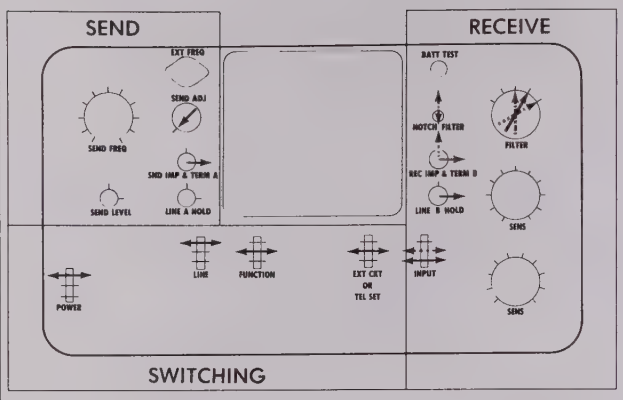
INPUT ..... **TERM or BRIDGE**
LINE B HOLD ..... **OFF**
REC IMP & TERM B ..... **600Ω or 900Ω**
NOTCH FILTER ..... **OUT**
FILTER ..... **15KC or HI-PASS**
SENS ..... **As required**
SENS ..... **As required**



ACTION	RESULT
1. Position Controls as shown above.	1. None
2. Patch line under test to B jack.	2. Meter needle may deflect.
3. Adjust two SENS switches (S8 and S10) as necessary to obtain meter indication between +3 dB and −3 dB on black scale.	3. Tone level measurement is the sum of SENS switch black settings and meter reading. Refer to paragraph 4.20 for examples.
4. To talk on line under test, connect lineman's handset to AX jack and position EXT CKT OR TEL SET switch to AX ON B MEAS A position (down). Use LINE B HOLD switch as required. NOTE A headset or other 600 ohm receiving device may be connected to AC MON jack J6 with negligible effect on power measurement.	4. Meter needle returns to left.

Table 4—15. Receive Noise Measurements (2-Wire)

TEST SET-UP



SEND SECTION

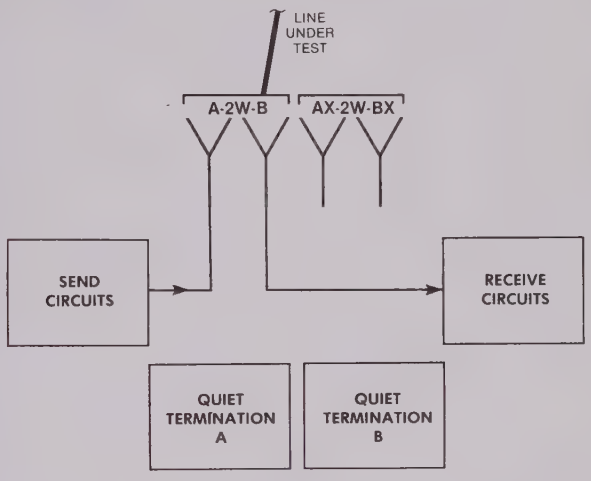
SEND FREQ. . . . . —
SEND ADJ. . . . . **OFF**
SEND LEVEL. . . . . —
SEND IMP & TERM A. . . . . —
LINE A HOLD . . . . . —

SWITCHING SECTION

POWER . . . . . **BATT**
LINE . . . . . **SND A-REC B**
FUNCTION . . . . . **2 WIRE (LA)**
EXT CKT OR TEL SET . . . . **MEAS A AND B**

RECEIVE SECTION

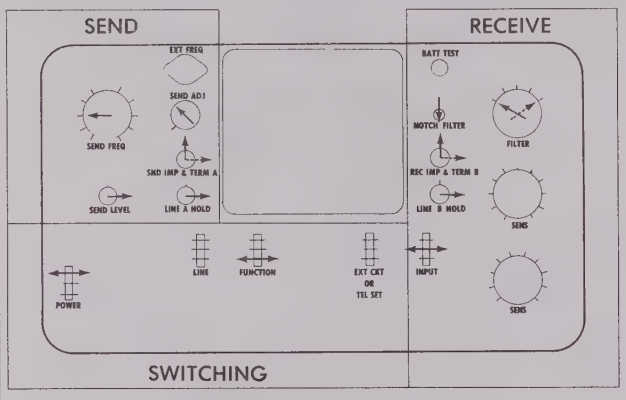
INPUT. . . . . **TERM or N-GND**
LINE B HOLD. . . . . **OFF**
REC IMP & TERM B . . . . . **600Ω or 900Ω**
NOTCH FILTER. . . . . **IN or OUT**
FILTER. . . . . **C-MSG, 3KC or 15KC**
SENS . . . . . **As required**
SENS . . . . . **As required**

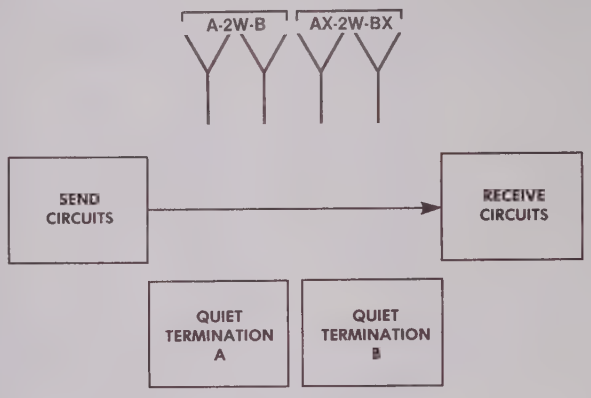


ACTION	RESULT
1. Position controls as shown above.	1. None
2. For metallic (balanced) noise measurement, set INPUT switch S7 to TERM. For noise-to-ground, (unbalanced) measurement, set S7 to N-GND.	2. None
3. For noise-with-tone (C-notch) measurement, set NOTCH FILTER switch S17 to IN position (up).	3. None
4. Patch line under test to B jack.	4. Meter needle may deflect.
5. Adjust two SENS switches (S8 and S10) as necessary to obtain meter indication between +7 dBrn and +13 dBrn on blue scale. NOTE For noise-to-ground measurements, connect front panel GND binding post to a good earth ground. Also, add 40 dBrn to all measurement results.	5. Noise measurement is sum of SENS switch blue settings and meter reading. Refer to paragraph 4.20 for examples.

Table 4—16. Send Section Operation (2-Wire)

TEST SET-UP





SEND SECTION

SEND FREQ	CAL 1000
SEND ADJ	ON
SEND LEVEL	0
SEND IMP & TERM A	600Ω or 900Ω
LINE A HOLD	OFF

SWITCHING SECTION

POWER	BATT
LINE	—
FUNCTION	SND ADJ
EXT CKT OR TEL SET	—

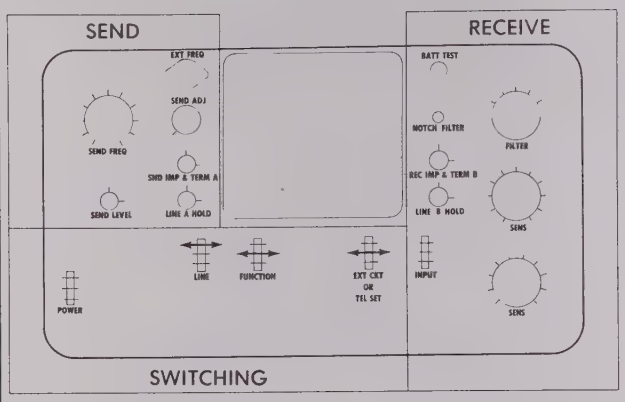
RECEIVE SECTION

INPUT	TERM
LINE B HOLD	OFF
REC IMP & TERM B	600Ω or 900Ω
NOTCH FILTER	OUT
FILTER	15KC (Blk) or 15KC (Blue)
SENS	As required
SENS	As required

ACTION	RESULT
OUTPUT LEVEL ADJUSTMENT	
1. Position controls as shown above.	1. Meter needle may deflect.
2. Set SND IMP & TERM A and REC IMP & TERM B switches to the same impedance as the circuit to be tested (either 600 or 900 ohms).	2. None
3. Adjust the two SENS switches (S8 and S10), SEND LEVEL switch S15 (0 or −10 dB) and SEND ADJ S13/R101 to obtain desired output level on meter M1.	3. Use the various switch combinations to obtain a reading near 0 dB on the black scale. Output level is the sum of SENS switch black settings and meter reading. Refer to paragraph 4.20 for examples.
NOTE Output level is set by SEND ADJ control. The SENS switches simply allow the output to be kept within meter range. They do not affect output level at front panel jacks.	

Table 4—16. (cont'd)

TEST SET-UP



SEND SECTION

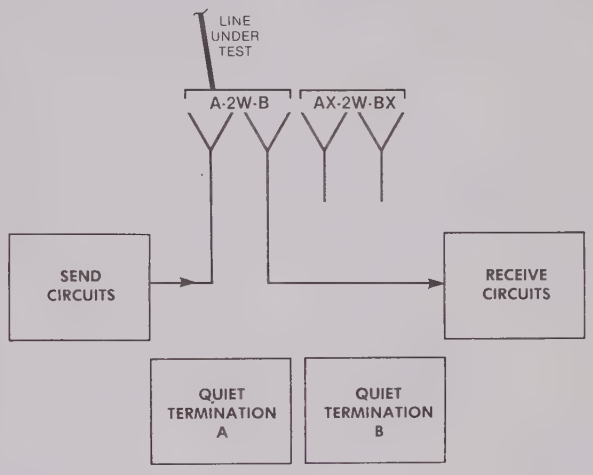
SEND FREQ	**As required**
SEND ADJ	—
SEND LEVEL	—
SEND IMP & TERM A	—
LINE A HOLD	—

SWITCHING SECTION

POWER	—
LINE	**SND A-REC B**
FUNCTION	**2 WIRE (LA)**
EXT CKT OR TEL SET	**MEAS A AND B**

RECEIVE SECTION

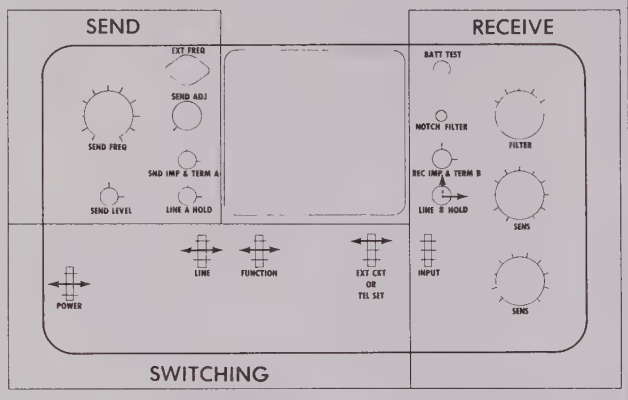
INPUT	—
LINE B HOLD	—
REC IMP & TERM B	—
NOTCH FILTER	—
FILTER	—
SENS	**As required**
SENS	**As required**

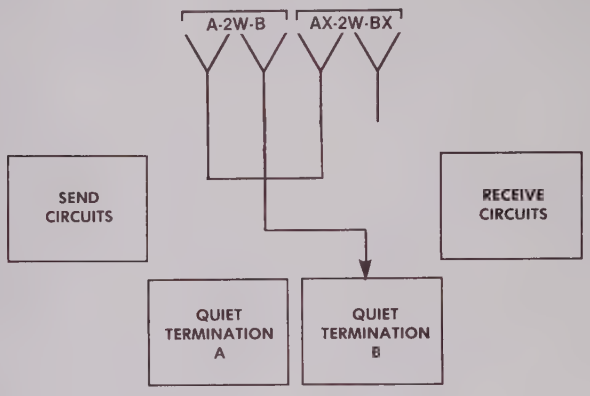


ACTION	RESULT
SEND PROCEDURE	
4. Position controls as shown above. Only **changes** in control settings are shown. Select desired SEND FREQ and check that FUNCTION switch is not in SND ADJ position.	4. Meter needle returns to left side of scale.
5. Patch line under test to A jack. NOTE If a receive measurement is to be made after sending, simply move the line switch: from SND A-REC B to REC A-SND B (When receiving it is often desirable to turn off the send oscillator by using the SEND ADJ control.)	5. Tone of selected frequency and level is now being transmitted into the line under test via jack A.

Table 4—17. Quiet Termination Selection (2-Wire)

TEST SET-UP





SEND SECTION

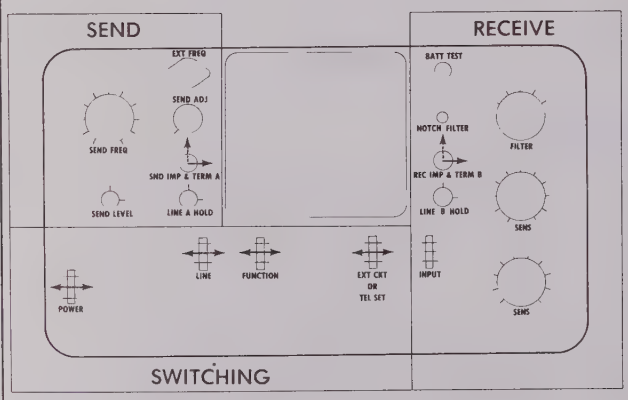
SEND FREQ. . . . . —
SEND ADJ. . . . . —
SEND LEVEL. . . . . —
SEND IMP & TERM A. . . . . —
LINE A HOLD . . . . . —

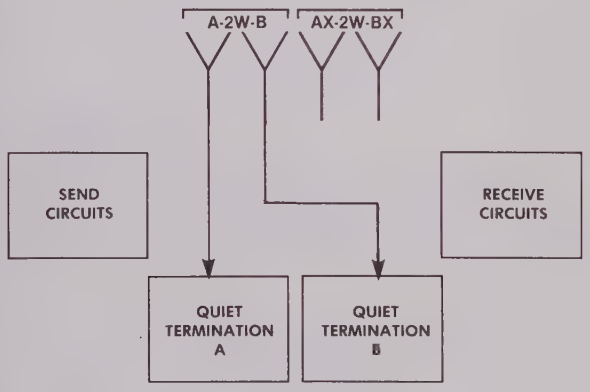
SWITCHING SECTION

POWER. . . . . **OFF**
LINE. . . . . **TERM A AND B**
FUNCTION . . . . . **2 WIRE (LA)**
EXT CKT OR TEL SET . . **AX ON A MEAS B**

RECEIVE SECTION

INPUT. . . . . —
LINE B HOLD . . . . . —
REC IMP & TERM B . . . . . **600Ω or 900Ω**
NOTCH FILTER. . . . . —
FILTER . . . . . —
SENS . . . . . —
SENS . . . . . —





SEND SECTION

SEND FREQ. . . . . —
SEND ADJ. . . . . —
SEND LEVEL. . . . . —
SEND IMP & TERM A. . . . . **600Ω or 900Ω**
LINE A HOLD . . . . . —

SWITCHING SECTION

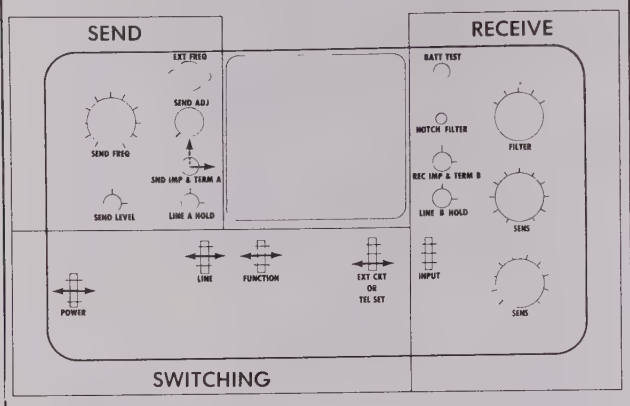
POWER. . . . . **OFF**
LINE. . . . . **TERM A AND B**
FUNCTION . . . . . **2 WIRE (LA)**
EXT CKT OR TEL SET . . . . **MEAS A AND B**

RECEIVE SECTION

INPUT. . . . . —
LINE B HOLD . . . . . —
REC IMP & TERM B . . . . . **600Ω or 900Ω**
NOTCH FILTER. . . . . —
FILTER . . . . . —
SENS . . . . . —
SENS . . . . . —

Table 4—17. (Cont'd)

TEST SET-UP



SEND SECTION

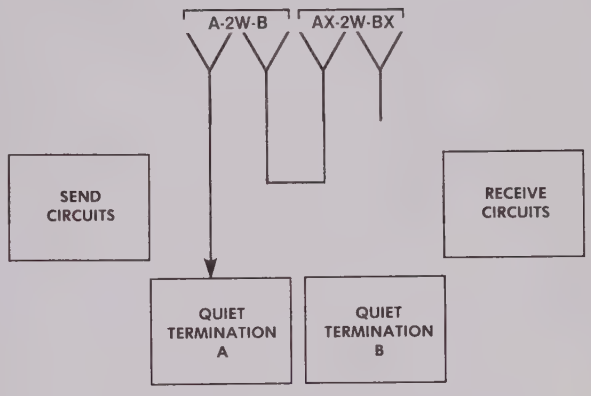
SEND FREQ. . . . . —
SEND ADJ. . . . . —
SEND LEVEL. . . . . —
SEND IMP & TERM A. . . . . **600Ω or 900Ω**
LINE A HOLD . . . . . —

SWITCHING SECTION

POWER. . . . . **OFF**
LINE . . . . . **TERM A AND B**
FUNCTION . . . . . **2 WIRE (LA)**
EXT CKT OR TEL SET . . **AX ON B MEAS A**

RECEIVE SECTION

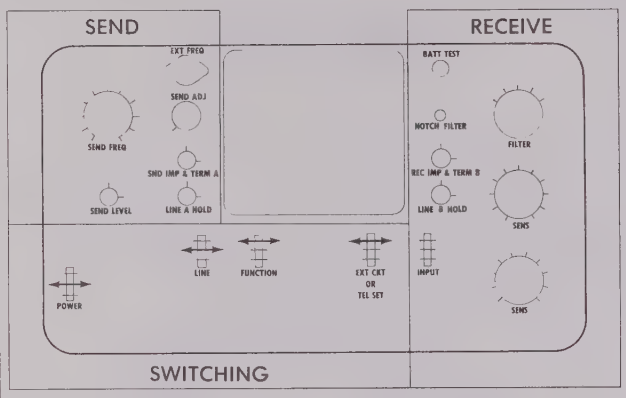
INPUT. . . . . —
LINE B HOLD . . . . . —
REC IMP & TERM B . . . . . —
NOTCH FILTER. . . . . —
FILTER . . . . . —
SENS . . . . . —
SENS . . . . . —



ACTION	RESULT
1. Select the appropriate termination(s) for the desired application and position the controls accordingly.	1. None. The test set acts as a passive termination on the end of a line being tested for noise, or balance.
2. Patch line(s) under test to A jack and/or B jack.	2. None. Lines now terminated with either 600 or 900 ohms plus 2 microfarads.

Table 4—18. Dial/Talk Procedure (4-Wire)

TEST SET-UP



SEND SECTION

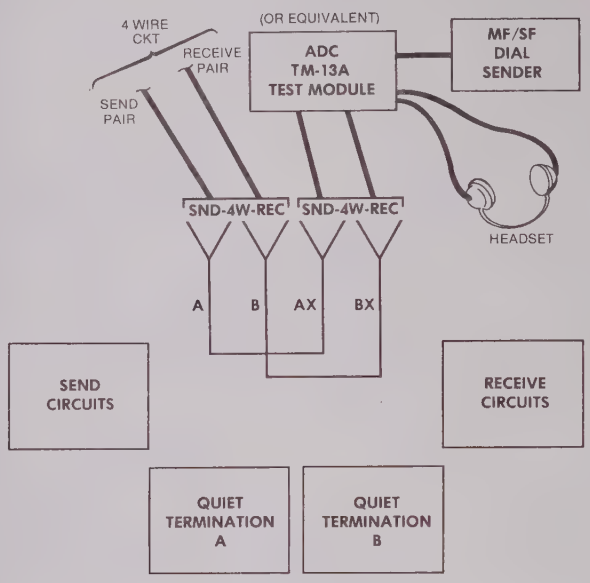
SEND FREQ — —
SEND ADJ. — —
SEND LEVEL — —
SEND IMP & TERM A — —
LINE A HOLD — —

SWITCHING SECTION

POWER — OFF
LINE — TERM A AND B
FUNCTION — 4 WIRE
EXT CKT OR TEL SET — AX ON A-BX ON B

RECEIVE SECTION

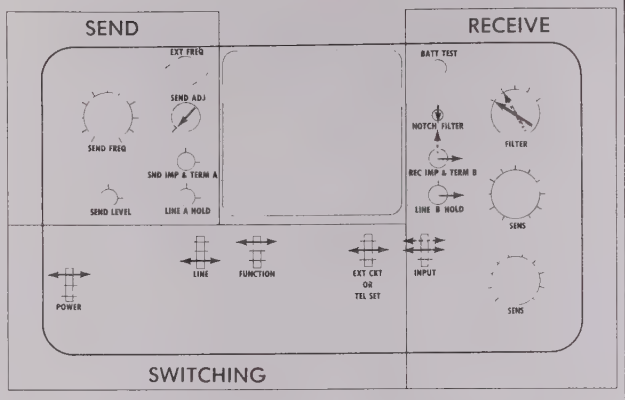
INPUT — —
LINE B HOLD — —
REC IMP & TERM B — —
NOTCH FILTER — —
FILTER — —
SENS — —
SENS — —



ACTION	RESULT
1. Position controls as shown above.	1. None
2. Patch a 2-wire to 4-wire test module such as the ADC TM-13A to the AX and BX jacks as shown.	2. None
3. Patch send pair to A jack and receive pair to B jack,	3. None
4. To dial on a 4-wire circuit, an MF or SF tone source may be connected to the 4-wire test module and to the transmit pair through the AX to A connections provided by the TTS-35.	4. None
5. To listen or talk on a 4-wire circuit, connect a type 52A headset to the test module.	5. Hear conversation.

Table 4—19. Receive Pair Tone Level Measurements (4-Wire)

TEST SET-UP



SEND SECTION

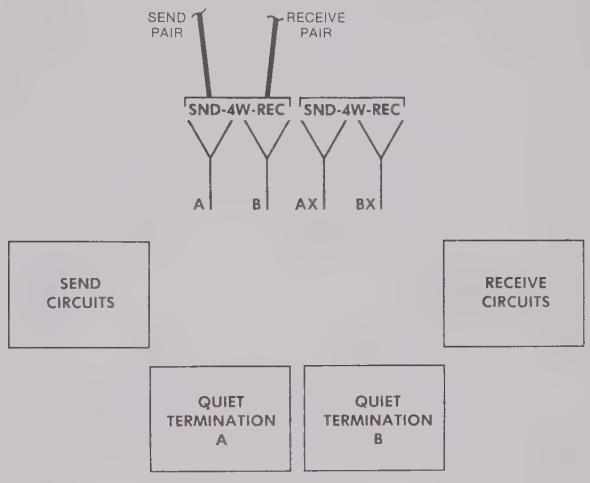
SEND FREQ. . . . . —
SEND ADJ . . . . . OFF
SEND LEVEL . . . . . —
SEND IMP & TERM A . . . . . —
LINE A HOLD . . . . . —

SWITCHING SECTION

POWER . . . . . BATT
LINE . . . . . REC B
FUNCTION . . . . . 4 WIRE
EXT CKT OR TEL SET . . . MEAS A AND B

RECEIVE SECTION

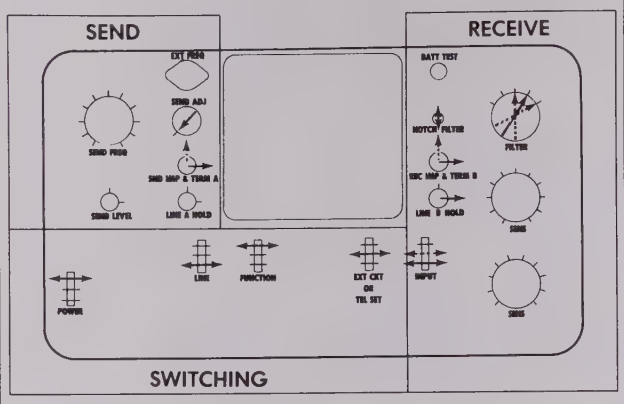
INPUT . . . . . TERM or BRIDGE
LINE B HOLD . . . . . OFF
REC IMP & TERM B . . . . . 600Ω or 900Ω
NOTCH FILTER . . . . . OUT
FILTER . . . . . 15KC or HI-PASS
SENS . . . . . As required
SENS . . . . . As required



ACTION	RESULT
1. Position controls as shown above.	1. None
2. Patch transmit branch to A jack and receive branch to B jack.	2. Meter needle may deflect.
3. Adjust SENS switches S8 and S10 as necessary to obtain meter indication between +3 dB and −3 dB on black scale.	3. Tone level measurement is the sum of SENS switch black settings and meter reading. Refer to paragraph 4.20 for examples.
NOTE A headset or other 600-ohm receiving device may be connected to AC MON jack J6 with negligible effect on power measurement.	

Table 4—20. Receive Pair Noise Measurement (4-Wire)

TEST SET-UP



SEND SECTION

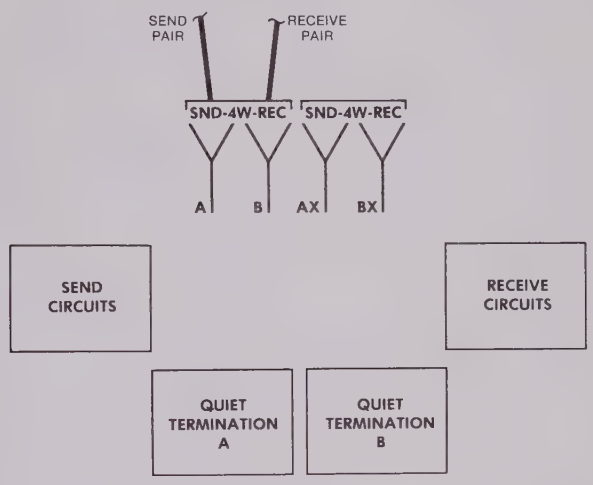
SEND FREQ. . . . . —
SEND ADJ. . . . . OFF
SEND LEVEL . . . . . —
SEND IMP & TERM A. . . . . 600Ω or 900Ω
LINE A HOLD . . . . . —

SWITCHING SECTION

POWER . . . . . BATT
LINE . . . . . REC B
FUNCTION. . . . . 4 WIRE
EXT CKT OR TEL SET . . . . MEAS A AND B

RECEIVE SECTION

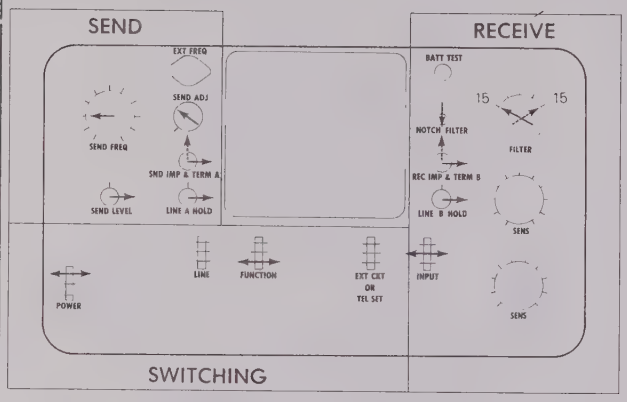
INPUT. . . . . TERM or N-GND
LINE B HOLD. . . . . OFF
REC IMP & TERM B . . . . . 600Ω or 900Ω
NOTCH FILTER. . . . . IN or OUT
FILTER . . . . . C-MSG, 3KC, or 15KC
SENS . . . . . As required
SENS . . . . . As required

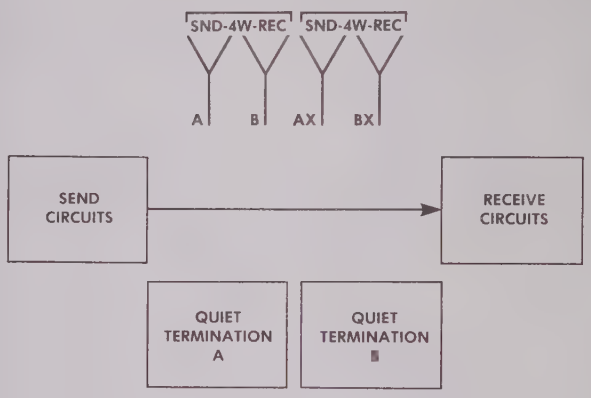


ACTION	RESULT
1. Position controls as shown above.	1. None
2. For metallic noise measurement, set INPUT switch S7 to TERM. For noise-to-ground measurements set S7 to N-GND.	2. None
3. For noise-with-tone measurement, set NOTCH FILTER switch S17 to IN position.	3. None
4. Patch transmit branch to A jack and receive branch to B jack.	4. Meter needle may deflect.
5. Adjust SENS switches S8 and S10 as necessary to obtain meter indication between +7 dBrn and +13 dBrn on blue scale.	5. Noise measurement is sum of SENS switch blue settings and meter reading. Refer to paragraph 4.20 for examples.
NOTE For noise-to-ground measurements, connect front panel GND binding post to a good earth ground. Also, add 40 dBrn to all measurement results.	

Table 4—21. Send Section Operation (4-Wire)

TEST SET-UP





send section

send freq	**cal 1000**
SEND ADJ	**ON**
SEND LEVEL	**0**
SEND IMP & TERM A	**600Ω or 900Ω**
LINE A HOLD	**OFF**

SWITCHING SECTION

POWER	**BATT**
LINE	**—**
FUNCTION	**SND ADJ**
EXT CKT OR TEL SET	**—**

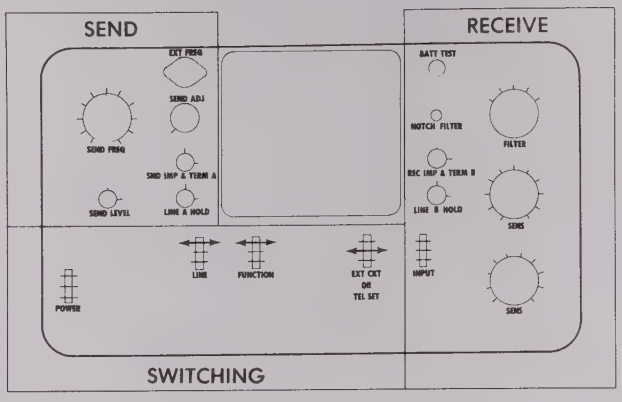
RECEIVE SECTION

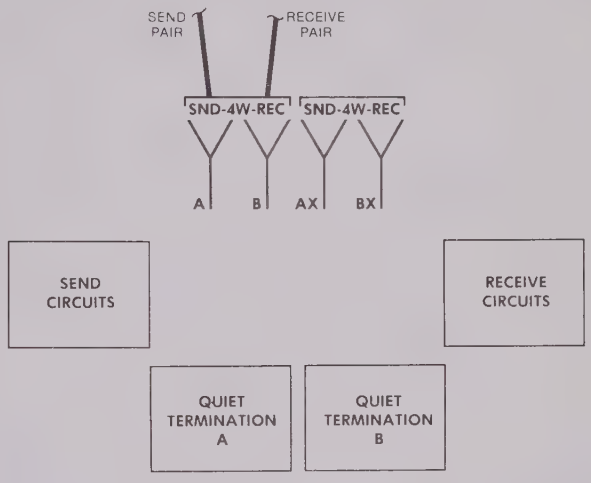
INPUT	**TERM**
LINE B HOLD	**OFF**
REC IMP & TERM B	**600Ω or 900Ω**
NOTCH FILTER	**OUT**
FILTER	**15KC (Blk) or 15 KC (Blue)**
SENS	**As required**
SENS	**As required**

ACTION	RESULT
OUTPUT LEVEL ADJUSTMENT	
1. Position controls as shown above. Be sure NOTCH FILTER switch is OUT, otherwise receive section is inoperative and meter is disabled.	1. Meter needle may deflect.
2. Adjust SENS switches S8 and S10, SEND LEVEL switch S15 (0 or −10 dB) and SEND ADJ S13/R101 to obtained desired output level on meter M1.	2. Use the various switch combinations to obtain a reading near 0 dB on the black scale. Output level is the sum of SENS switch black settings and meter reading. Refer to paragraph 4.20 for examples.
NOTE Output level is set by SEND ADJ control. The SENS switches simply allow the output to be kept within meter range. They do not affect output level at front panel jacks.	

Table 4—21. (cont'd)

TEST SET-UP





SEND SECTION

SEND FREQ	As required
SEND ADJ	—
SEND LEVEL	—
SEND IMP & TERM A	—
LINE A HOLD	—

SWITCHING SECTION

POWER	—
LINE	SND A
FUNCTION	4 WIRE
EXT CKT OR TEL SET	MEAS A AND B

RECEIVE SECTION

INPUT	—
LINE B HOLD	—
REC IMP & TERM A	—
NOTCH FILTER	—
FILTER	—
SENS	As required
SENS	As required

ACTION	RESULT
SEND PROCEDURE	
4. Position controls as shown above. Only **changes** in control settings are shown. Select desired SEND FREQ.	4. Meter needle returns to left side of scale.
5. Patch send branch to A jack and receive branch to B jack.	5. Tone of selected frequency and level is now being transmitted into the send pair.
6. To simultaneously send on A jack and make receive measurements on B jack, set FUNCTION switch to 2 WIRE (LA) position and LINE switch to SND A-REC B position. Refer to Table 4—19 for specific receive measurement procedures.	6. Meter needle may deflect. New test set-up shown below.

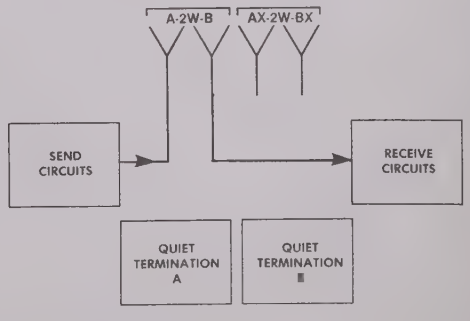
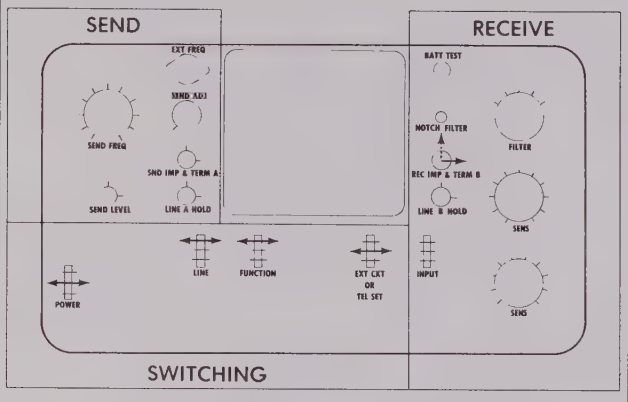


Table 4—22. Quiet Termination Selection (4-Wire)



SEND SECTION

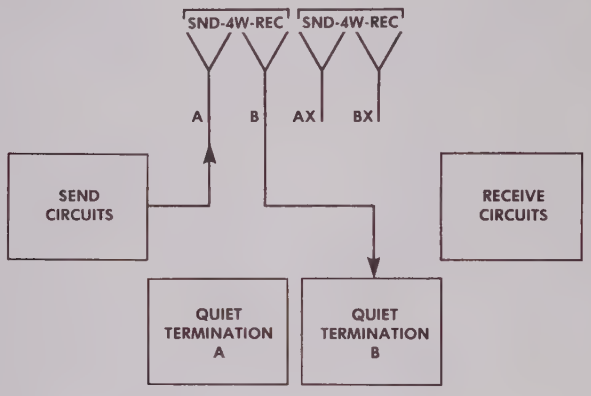
SEND FREQ — —
SEND ADJ — —
SEND LEVEL — —
SEND IMP & TERM A — —
LINE A HOLD — —

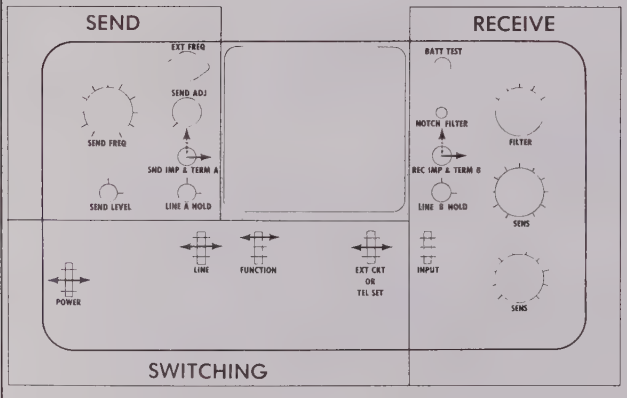
SWITCHING SECTION

POWER — OFF
LINE — SND A
FUNCTION — 4 WIRE
EXT CKT OR TEL SET — MEAS A AND B

RECEIVE SECTION

INPUT — —
LINE B HOLD — —
REC IMP & TERM B — 600Ω or 900Ω
NOTCH FILTER — —
FILTER — —
SENS — —
SENS — —





SEND SECTION

SEND FREQ — —
SEND ADJ — —
SEND LEVEL — —
SEND IMP & TERM A — 600Ω or 900Ω
LINE A HOLD — —

SWITCHING SECTION

POWER — OFF
LINE — TERM A AND B
FUNCTION — 4 WIRE
EXT CKT OR TEL SET — MEAS A AND B

RECEIVE SECTION

INPUT — —
LINE B HOLD — —
REC IMP & TERM B — 600Ω or 900Ω
NOTCH FILTER — —
FILTER — —
SENS — —
SENS — —

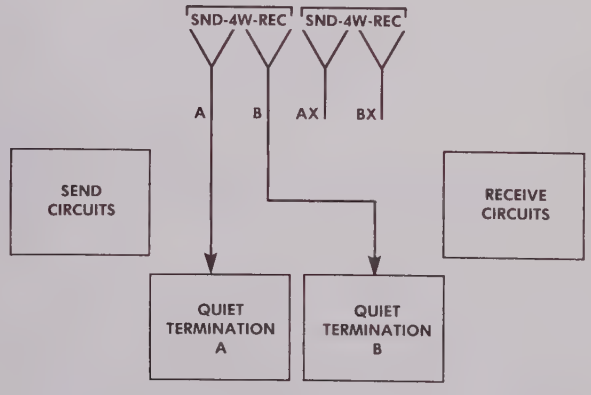
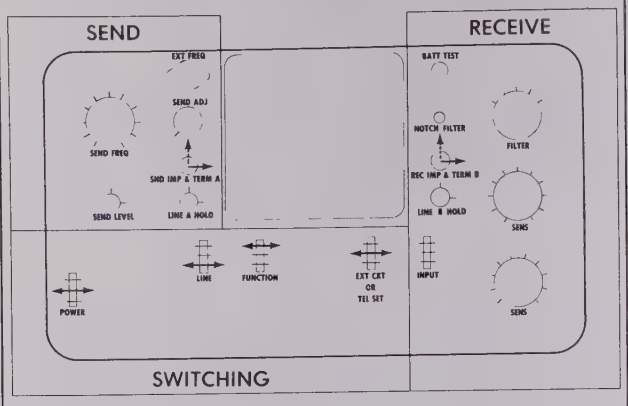


Table 4—22. (cont'd)

TEST SET-UP



SEND SECTION

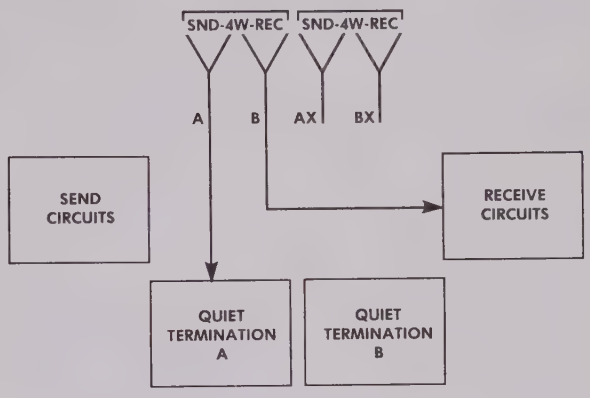
SEND FREQ ..... —
SEND ADJ ..... —
SEND LEVEL ..... —
SEND IMP & TERM A ..... 600Ω or 900Ω
LINE A HOLD ..... —

SWITCHING SECTION

POWER ..... OFF
LINE ..... REC B
FUNCTION ..... 4 WIRE
EXT CKT OR TEL SET ..... MEAS A AND B

RECEIVE SECTION

INPUT ..... —
LINE B HOLD ..... —
REC IMP & TERM B ..... —
NOTCH FILTER ..... —
FILTER ..... —
SENS ..... —
SENS ..... —



ACTION	RESULT
1. Select the appropriate termination(s) for the desired application and position the controls accordingly.	1. None. The test set acts as a passive termination on the end of a circuit's pair(s) being tested for noise, or balance.
2. Patch send branch to A jack and receive branch to B jack.	2. None. Circuit pair(s) now terminated with either 600 or 900 ohms plus 2 microfarads.

4.36 CIRCUIT TEST APPLICATIONS

4.37 Four typical tests for active circuits are presented as follows:

1. Signal-to-noise ratio. $\left[\frac{S+N}{N}\right]$
2. Circuit balance.
3. Repeater/Amplifier gain.
4. Attenuation Distortion.

4.38 **Signal-To-Noise Ratio**

4.39 This circuit parameter may be calculated from two simple measurements made with a TTS-35 Series test set and a 1004-Hz test line (or other signal source) at the far end. First the test line number is dialed over the circuit to be measured. The line is held while the TTS-35 Series test set is used to measure the received tone level. This is the signal plus noise power (S + N).

4.40 Next, the test set controls are changed to remove the 1004-Hz tone (using the notch filter) and simultaneously measure the noise power against a standard reference of 90 dB (using the C-message weighting filter). This provides the noise power measurement (N).

4.41 The simple calculation is performed using the measurements obtained to determine $\frac{S+N}{N}$. For example if the tone level is −20 dBm (S + N) and the noise measurement is +23 dBrnC, the $\frac{S+N}{N}$ ratio is simply the difference between the two logarithmic power levels (subtraction of logarithms equals arithmetic division).

4.42 The +23 dBrnC is converted to dB by subtracting 90 dB which is the reference level. This leaves −67 dB. It is subtracted from the S + N as follows:

$$\log S + N - \log N = \log \frac{S+N}{N}$$

$$-20\ dB - (-67\ dB) = 47\ dB$$

Thus, the signal-to-noise ratio for this example is expressed as 47 dB.

4.43 To calculate the signal-to-noise ratio, proceed as follows:

1. Refer to Table 4−13 (2 wire) or Table 4−18 (4 wire) to dial and hold a 1004 Hz test line.

2. Refer to Table 4−14 (2 wire) or Table 4−19 (4 wire) and measure the received tone level (S + N).

3. Refer to Table 4−15 (2 wire) or Table 4−20 (4 wire) and measure the received noise. This measurement is made with the NOTCH FILTER switch IN and the FILTER switch in the NOISE C-MSG position. Also, the INPUT switch is placed in the TERM position for a metallic noise measurement.

4. Subtract 90 dB from the C-message noise measurement in dBrnC to obtain N expressed in dB.

5. Subtract N (in dB) from the S + N (in dB) measured in step 2 to obtain the signal-to-noise ratio (in dB).

4.44 **Circuit Balance**

4.45 This circuit parameter is a measure of communications performance, particularly the susceptibility of the circuit to induced noise. It is measured by subtracting the balanced noise level from the unbalanced noise level. These level measurements may be made by: (1) dialing and holding a balanced (quiet termination) test line over the circuit to be tested, and then (2) measuring the noise-to-ground (unbalanced noise) and the metallic noise (balanced noise). Both measurements are made with reference to 90 dB using C-message filter weighting (dBrnC).

NOTE

The quiet terminations in a TTS-35 Series test set can be used at the far end of a line under test if a dialable balance test line is not available at the far end.

4.46 The difference between the noise-to-ground measurement and the metallic noise measurement is representative of the circuit balance. For example, if noise-to-ground is 83 dBrnC and metallic noise is 20 dBrnC, the circuit balance is 63 dB.

4.47 To calculate circuit balance, proceed as follows.

1. Refer to Table 4−13 (2 wire) or Table 4−18 (4 wire) to dial and hold a test line.

2. Refer to Table 4−15 (2 wire) or Table 4−20 (4 wire) and measure noise-to-ground with the FILTER switch in the C-MSG position.

3. Refer to Table 4−15 (2 wire) or Table 4−20 (4 wire) and measure metallic noise with the FILTER switch in the C-MSG position.

4. Subtract the noise measured in step 3 (balanced noise) from the noise measured in step 2 (unbalanced noise). The difference is circuit balance in dB.

4.48 **Repeater/Amplifier Gain**

4.49 Insertion loss or gain of four terminal networks such as filters, transformers, switchboard circuits and repeater/amplifiers may be measured using the SND A-REC B or REC A-SND B positions of the test set's LINE switch.

4.50 A fixed frequency signal with a preset level such as 0 dBm may be transmitted through the A jack to the device being tested. The output of the device may be applied to the test set receive circuits through the B jack. Subtracting the send level from the receive level measures the gain (+) or loss (−).

4.51 For a 0 dBm send signal, meter readings above 0 dBm indicate gain and readings below indicate loss. To measure gain or loss, refer to Table 4−16 (2 wire) or Table 4−21 (4 wire) for send section operation and to Table 4−14 (2 wire or 4 wire) for receive section operation. Subtract send level from receive level to determine gain or loss.

4.52 **Attenuation Distortion**

4.53 Attenuation distortion is found by measuring circuit loss at 404 Hz and 2804 Hz and comparing these values with the loss measured at 1004 Hz. Comparing the loss measurements results in positive or negative slope values depending on whether the loss at the end frequencies is higher (positive slope) or lower (negative slope) than the mid-frequency loss. Since these values show differences in transmission loss at three frequencies, they provide a measure of the circuit's frequency response.

4.54 A co-operating test set capable of generating the necessary signal frequencies is required at the far end of the circuit to be tested. After communications have been established at both ends, refer to Table 4−14 for receive level measurement procedures and proceed as follows:

1. Measure and record the tone levels during each of the three frequencies (1004 Hz, 404 Hz and 2804 Hz).

2. Calculate attenuation distortion by determining the difference in loss between the first and second tones and the first and third tones.

4.55 MEASUREMENTS TO COMMON TEST LINES

4.56 Five typical tests using common test lines are presented as follows:

1. Type 100-Balance Test Line

2. Type 102-Milliwatt Test Line

3. Type 104-Transmission Measuring and Noise Checking

4. Type 107-Data Transmission

5. Loop-Around (Northeast TTS-52 or equivalent).

4.57 **Type 100-Balance Test Line (See Figure 4−10)**

4.58 This is a dialable test line that provides: (1) off-hook supervision to the calling party end as long as the line is held by the calling end, (2) a quiet termination of 600 or 900 ohms plus a capacitance, and (3) newer versions of the test line provide approximately ½ second of milliwatt signal. These characteristics of the test line, as shown in Figure 4−10, allow loss and noise measurements to be made with one call.

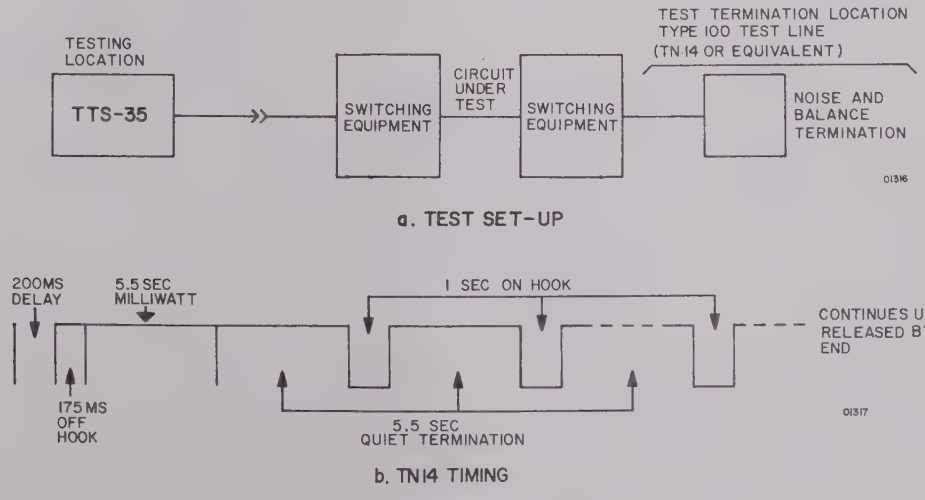


Figure 4−10. Type 100 Test Line Set-Up

4.59 Loss measurements must be made during the 5.5 second milliwatt tone interval. After this interval, 5.5 second intervals of quiet termination (interrupted by 1 second on-hook intervals) continue until the test line is released at the TTS-35 end. If the loss measurement is not completed before the end of the 5.5 second milliwatt interval, release and re-dial the test line as necessary.

4.60 To perform loss and noise measurements, proceed as follows:

1. Refer to Table 4—13 (2 wire) or Table 4—18 (4 wire) to dial and hold the test line. Prior to dialing, connect circuit to be tested to LINE B jack and place EXT CKT OR TEL SET switch to AX ON B MEAS A position rather than the positions shown in Table 4—13 or Table 4—18.

2. As soon as dialing is complete, **immediately** place EXT CKT OR TEL SET switch to MEAS A AND B position and monitor meter M1 for a milliwatt tone level. Refer to Table 4—14 (2 wire) or Table 4—19 (4 wire) to select 600 or 900 ohm impedance and to set up the TTS-35 to measure the milliwatt level.

NOTE

To repeat tone measurement, place LINE B HOLD switch OFF then ON again. Re-dial test line number and repeat measurement sequence. The milliwatt tone is present for approximately 5.5 seconds after dialing is completed.

3. When the milliwatt tone ends, measure the received noise. Refer to Table 4—15 (2 wire) or Table 4—20 (4 wire). Select either metallic noise or noise-to-ground along with the appropriate noise weighting filter.

4. When tone and noise measurements are completed, release the test line by placing LINE B HOLD switch OFF

4.61 **Type 102-Milliwatt Test Line (See Figure 4—11)**

4.62 This dialable test line provides a calibrated test signal at a milliwatt power level and at a frequency of 1000 Hz or 1004 Hz, typically. One-way transmission loss measurements may be made with this test line from the TTS-35.

4.63 Northeast's TTS-39 Series test line and others typically provide the following repetitive sequence: (1) nine seconds off-hook with the test tone present and (2) one second on-hook without the test tone. The sequence repeats until the test line is released at the TTS-35 end.

4.64 Other types of test lines provide: (1) an initial interval of off-hook with the test tone present followed by (2) a continuous on-hook without the test tone. The sequence is not repetitive. On-hook without tone lasts until the test line is released. A quiet termination may be provided during the on-hook periods for both types.

4.65 To perform loss measurements, proceed as follows:

1. Refer to Table 4—13 (2 wire) or Table 4—18 (4 wire) to dial and hold the test line.

2. Refer to Table 4—14 (2 wire) or Table 4—19 (4 wire) to measure the calibrated milliwatt tone.

3. When the measurement is finished, release the test line by placing LINE B HOLD switch OFF.

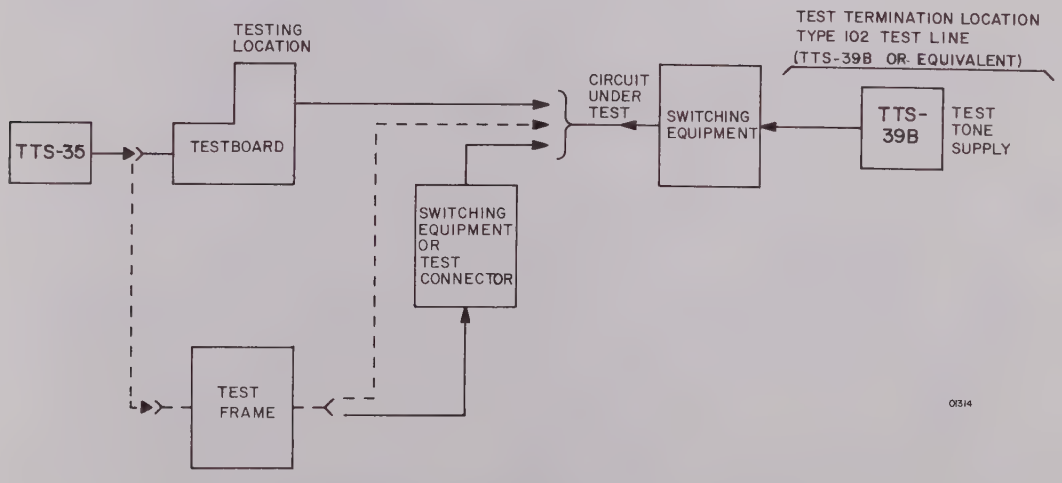


Figure 4—11. Type 102 Test Line Set-Up

4.66 Type 104-Transmission Measuring and Noise Checking (See Figure 4—12)

4.67 This dialable test line allows two-way transmission measurements to be made by one craftsman from a test board or a maintenance center using the TTS-35.

4.68 As shown in Figure 4—12, the test line provides a sequence of signals that allow near-to-far end loss to be calculated easily. The craftsman operating the TTS-35 cooperates during the sequence by detecting the test progress tones (TPT's) and switching the TTS-35 between send and receive as required.

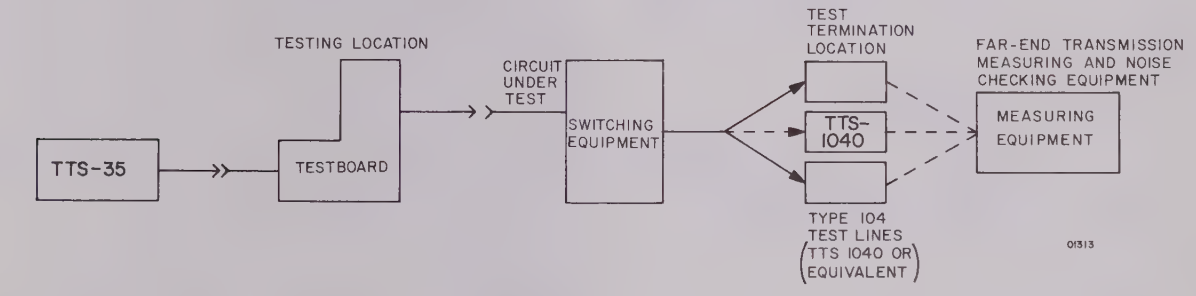
4.69 When the Type 104 test line receives the 6 seconds of milliwatt tone from the TTS-35, the type 104 measures the level. The resulting loss is used to set an attenuator in the test line output so that a milliwatt signal into the attenuator is transmitted at the same level as the received near-to-far end signal.

4.70 The test line transmits a milliwatt tone at 1000 Hz first and then transmits the re-created near-to-far tone which equals a milliwatt minus the loss introduced by the transmit attenuator. These two signals are measured by the TTS-35 and used to calculate near-to-far end loss as shown in Figure 4—12.

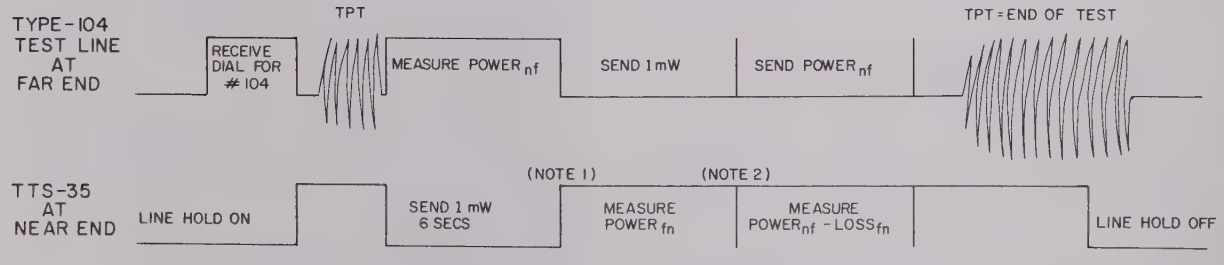
4.71 The type 104 test line is often used to test trunks from offices equipped with automatic transmission measuring systems (ATMS). To use the TTS-35 in conjunction with the test line, the craftsman must comply with the test line's operating/timing sequence.

NOTE

Several versions of type 104 test lines are in use. Each version has slight differences in timing and signaling, although the overall operating sequences are essentially alike. The following procedures outline a general method for using the TTS-35 with a type 104 test line. The procedure should be modified as necessary to adapt it to a specific type 104 test line.



a. TEST SET UP



1. CALCULATE: $LOSS_{fn} = 1\ mW - POWER_{fn}$
2. CALCULATE: $POWER_{nf} = (POWER_{nf} - LOSS_{fn}) + LOSS_{fn}$
3. CALCULATE: $LOSS_{nf} = 1\ mW - POWER_{nf}$

LEGEND
nf = NEAR TO FAR
fn = FAR TO NEAR
TPT = TEST PROGRESS TONE (2225 HZ)

b. TTS-1040 SEQUENCE 80688

Figure 4—12. Type 104 Test Line Set-Up

4.72 To perform loss measurements with a type 104 test line, proceed as follows:

1. Refer to Table 4—16 (2 wire) or Table 4—21 (4 wire) to set the send level to 1000 Hz at 0 dBm into 600 or 900 ohms as applicable.

2. Refer to Table 4—14 (2 wire) or Table 4—19 (4 wire) and set the controls to measure a 0 dBm receive signal.

3. Connect a type 52A or equivalent headset to the AC MON jack in order to hear the TPT signaling associated with this test.

4. Refer to Table 4—13 (2 wire) or Table 4—18 (4 wire) to dial and hold the test line.

5. When the first TPT ends, change LINE switch from SND A-REC B to REC A-SND B for six seconds.

6. Place LINE switch back to SND A-REC B and listen for a TPT requesting a repeat transmission or observe and record meter reading of received far-to-near signal if a TPT is not received. If the repeat TPT is received, perform steps 5 and 6 again. Up to two repeat requests may occur.

NOTE

At this point in the sequence some type 104 test lines allow the craftsman to request up to two repeat tone level transmissions.

7. Listen for "add 10" signal (short burst of TPT).

8. Observe and record the received tone level. This is the near-to-far signal minus the far-to-near loss.

9. Calculate the far-to-near loss by subtracting the value recorded in step 6 from 0 dB.

10. Calculate the near-to-far received power by adding the value calculated in step 9 to the one recorded during step 8.

11. Calculate the near-to-far loss by subtracting the value in step 10 from 0 dB. If an "add 10" TPT is received during step 7, add 10 dB to the calculated near-to-far loss.

NOTE

Some type 104 test lines allow repeat loss measurements requests to be made by the craftsman at this point.

12. Listen for an interrupted TPT indicating that near-to-far noise check exceeded threshold level. If necessary, repeat entire test sequence.

13. Listen for steady TPT indicating end of test. Place LINE HOLD switch OFF to release test line.

4.73 **Type 107-Data Transmission Test Line (See Figure 4—13)**

4.74 The type 107 is a dialable test line which provides connection to a signal source that supplies test signals for one-way measurement of data and voice transmission parameters. The test line provides: (1) peak-to-average ratio (P/AR) signal, (2) gain-slope frequencies, and (3) quiet termination.

4.75 The TTS-35 can be used in conjunction with a type 107 test line to measure tone level, circuit noise, noise-with-tone, noise-to-ground, signal-to-noise ratio, circuit balance, and attenuation distortion.

4.76 Upon seizure, the type 107 test line generates the sequence of tones shown in Figure 4—13. The first in the sequence (P/AR) is not used for measurements with a TTS-35 test set. The three gain-slope frequencies typically are sent at —16 dBm and are used to measure attenuation distortion. The 20-second quiet termination may be used to measure message circuit noise and noise-to-ground. The two 17-minute intervals of 1004 Hz, typically sent at —16 dBm, are used to measure tone level and noise-with-tone.

4.77 Procedures for making these measurements are described under the general operating procedures and the circuit test applications. Two-wire tests are summarized in Table 4—10, 4-wire tests in Table 4—11 and attenuation distortion is described in paragraph 4.52. To perform the measurements available with a type 107 test line, proceed as follows.

1. **Audio Monitor.** Connect a type 52A headset or equivalent to the test set AC MON jack in order to hear the test signals and to control the measurement sequence at the TTS-35 end.

2. **Recieve Measurements.** Refer to Table 4—14 (2 wire) or Table 4—19 (4 wire) and set the controls for tone measurement. Select the appropriate receive impedance.

3. **Dial and Hold.** Refer to Table 4—13 (2 wire) or Table 4—18 (4 wire) to dial and hold the type 107 test line.

4. **Attenuation Distortion.** Measure and record the tone levels during each of the three gain-slope frequencies. Calculate attenuation distortion by determining the difference in loss between the first and second tones and the first and third tones (see Figure 4—13).

5. **Circuit Noise Measurement.** Refer to Table 4—15 (2 wire) or Table 4—20 (4 wire) and measure circuit noise and noise-to-ground during the 20 second quiet termination interval.

6. **Noise-With-Tone Measurements.** During the 17 minute intervals of 1004 Hz tone, the signal-to-noise ratio and circuit balance may be measured. Refer to paragraph 4.38 for signal-to-noise ratio measurement procedures and to paragraph 4.44 for circuit balance procedures.

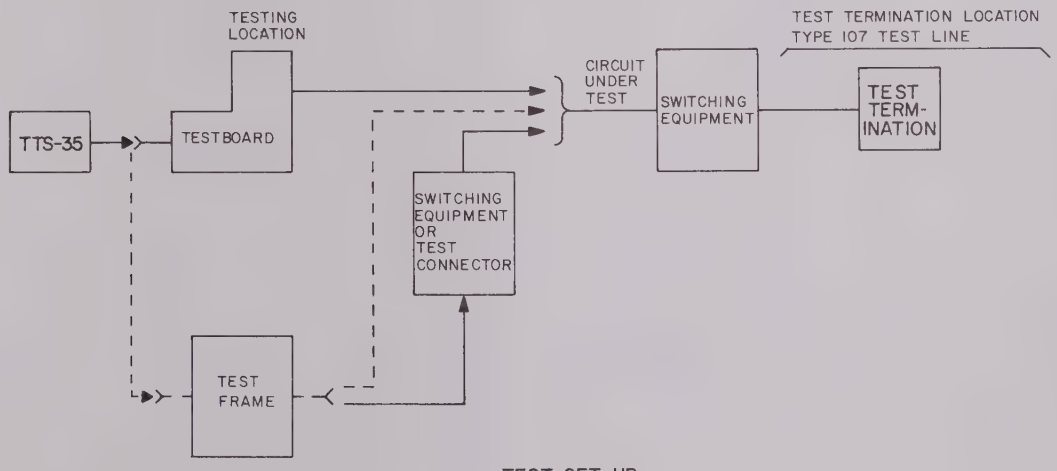
7. When measurements are finished, place LINE HOLD switch OFF to release test line.

4.78 Loop Around Measurements

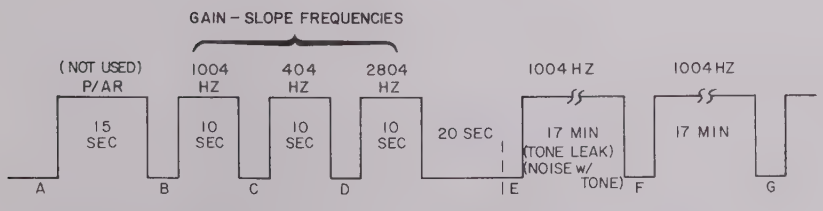
4.79 These tests allow loss to be determined in both directions on 2 wire, 2 way trunks. All tests are performed from one office by one craftsman assuming that a dialable loop-around test line such as the Northeast TTS-52 or equivalent is available for use at the far ends of circuits to be tested. The loop-around test line has two separate line terminations. Each termination is reached by dialing a different, customer-type telephone number. When the second, customer-type number is dialed after one trunk is connected to the first termination, a one milliwatt signal is removed from the first trunk and both trunks are connected together at the far end. This allows the near end (TTS-35) to transmit a test tone for loop-around.

4.80 Actual practices differ according to the type of loop-around test lines being used and its operating procedures. Table 4—23 provides a typical procedure for measurement of near and far end losses for two trunks in a group. If desired, one trunk may be used as a reference trunk and then all remaining trunks of interest may be measured with reference to that trunk.

4.81 Refer to Table 4—23 for specific procedures using a Northeast TTS-52 or equivalent loop-around test set and the TTS-35.



a. TEST SET UP



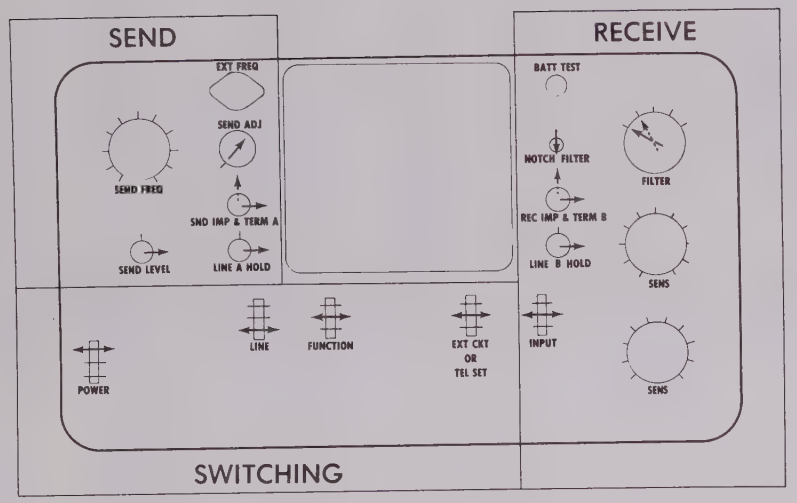
A - 200 MILLISECONDS OFF-HOOK (QUIET TERMINATION)
B, C, D - 1 SECOND OFF-HOOK (QUIET TERMINATION)
E, F, G - 3 SECONDS ON-HOOK FOLLOWED BY 300 MILLISECONDS OFF-HOOK.

01312

b. TIMING SEQUENCE

Figure 4—13. Type 107 Test Line Set-Up

Table 4—23. Loop Around Measurements (Near End and Far End Loss)



SEND SECTION

SEND FREQ	**As required**
SEND ADJ	**ON**
SEND LEVEL	**0**
SEND IMP & TERM A	**600 or 900**
LINE A HOLD	**OFF**

SWITCHING SECTION

POWER	**BATT**
LINE	**REC A-SND B**
FUNCTION	**2 WIRE (LA)**
EXT CKT OR TEL SET	**MEAS A AND B**

RECEIVE SECTION

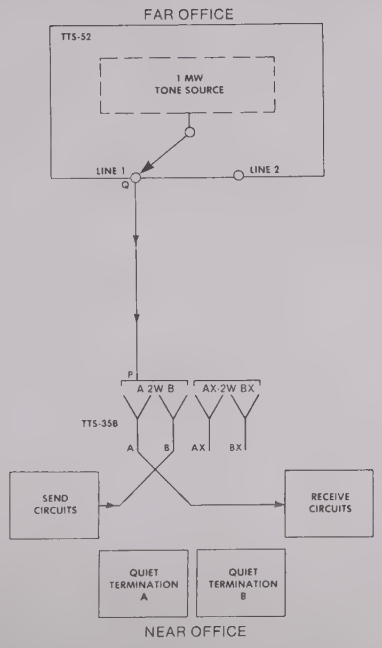
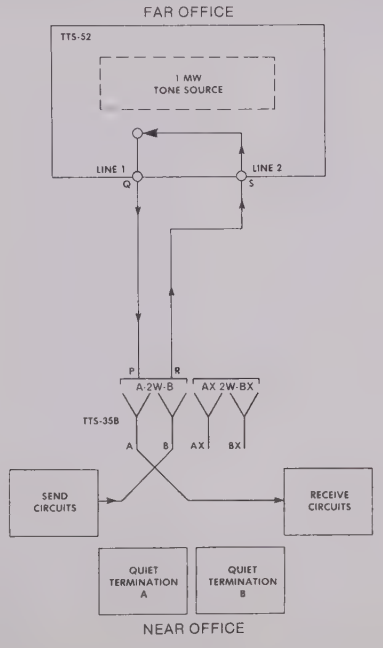
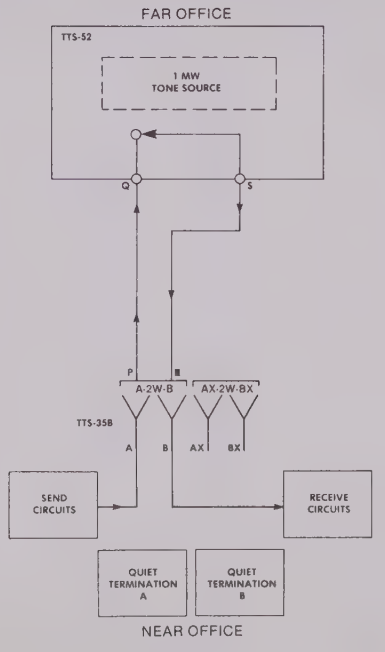
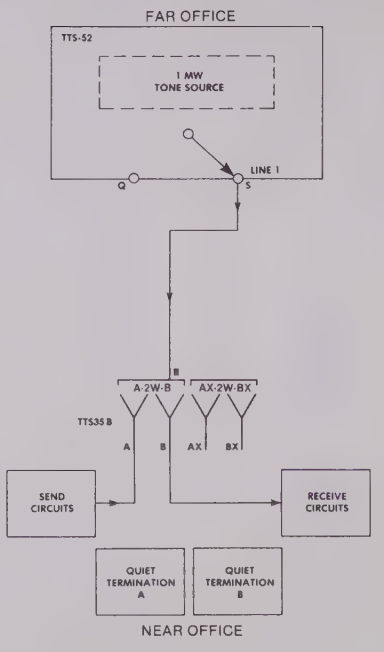
INPUT	**TERM**
LINE B HOLD	**OFF**
REC IMP & TERM B	**600 or 900**
NOTCH FILTER	**OUT**
FILTER	**15CK or HI-PASS**
SENS	**As required**
SENS	**As required**

1. Connect trunks as instructed below according to the typical test set-ups.

2. Position controls on TTS-35 as shown in the adjacent illustration.

3. Turn on and adjust TTS-35 to desired send level and frequency as described in Table 4—15 (2 wire) or Table 4—21 (4 wire). (Typically 1 milliwatt at 1000 Hz.)

Table 4—23. (cont'd)

LOSS FROM Q—P	LOSS FROM R—S	LOSS FROM P—R	LOSS FROM S—R & LOSS FROM P—Q
5. Patch QP to the A jack on the TTS-35. 6. Seize trunk QP as described in Table 4—13 (2-wire) or Table 4—18 (4-wire). 7. On trunk QP, dial far end office, line 1. 8. Measure and record test signal power. The difference between this level and 1 milliwatt is the far end loss of trunk QP.	9. Patch RS to the B jack on the TTS-35B. 10. Seize trunk RS as described in Table 4—13 or Table 4—18. 11. Set A HOLD switch to ON. 12. On trunk RS, dial far end office, line 2. 13. Measure and record test signal power from TTS-35B generated signal. Calculate loss. 14. Subtract loss measured in step 8 from that measured in step 13. This is the near end loss of trunk RS.	15. Set B HOLD switch ON. 16. Set LINE switch to SND A-REC B. 17. Measure and record test signal power. Calculate loss. This is the overall loss from P to Q to S to R and is used during the next test set-up.	18. Set A HOLD and B HOLD switches to OFF to releast trunks. 19. On trunk RS, dial far end office line 1. 20. Measure and record test signal power. Calculate loss. This is the far end loss from S to R. 21. Subtract the loss determined above from that obtained in step 17. This is the near end loss from P to Q.
			

4.82 COVER ACCESSORY OPERATING PROCEDURES

4.83 Tables 4—24 through 4—26 provide procedures for operating the following accessories:

1. TTS-35XPS Ac Power Supply Adapter
2. TTS-35XV Continously Variable Frequency Adapter
3. TTS-35XDT Dial and Talk Adapter

Table 4—24. TTS-35XPS Power Supply Operating Procedures

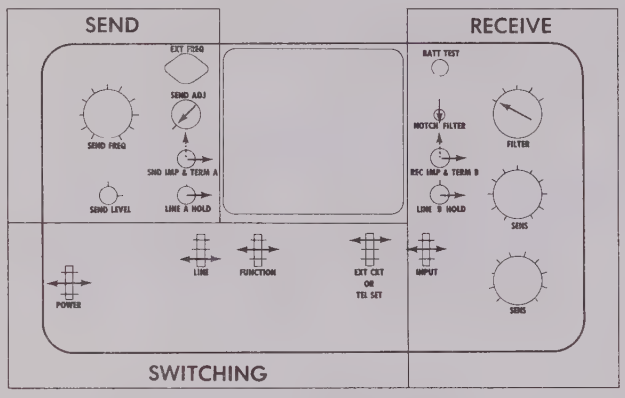
ACTION	RESULT
1. Place POWER switches on TTS-35 and TTS-35XPS OFF.	1. None
2. Open storage compartment door on TTS-35XPS and extend ac power cord.	2. None
3. Connect power cord to 110 Vac outlet.	3. None
4. Connect 310-type telephone cord between 48V jack on TTS-35XPS and 48V jack on TTS-35. Cord must have tip/ring conductors.	4. None
5. Place TTS-35XPS POWER switch ON and then place TTS-35 POWER switch to 48V position.	5. TTS-35 meter needle may deflect momentarily.
6. Press BATT. TEST pushbutton on TTS-35.	6. Meter needle should indicate in green arc marked GOOD on BATT TEST scale.
7. To remove power, place TTS-35 POWER switch OFF first and then place TTS-35XPS POWER switch OFF.	8. None
CAUTION **Do not connect the TTS-35XPS to the TTS-35 with the TTS-35XPS turned on. Also, do not disconnect the 48 volt power cord until the TTS-35XPS has been turned off. This prevents transient voltages from damaging the equipment.**	

Table 4—25. TTS-35XV Frequency Adapter Operating Instructions

ACTION	RESULT
1. Connect cable connector P1 from the TTS-35XV to EXT FREQ jack on TTS-35.	1. None.
2. Place SEND FREQ switch on TTS-35 to EXT.	2. None.
3. Use RANGE switch on TTS-35XV to select desired frequency range.	3. A = 200 to 700 Hz, B = 600 to 2100 Hz, A x 10 = 2000 to 7000 Hz.
4. Use frequency tuning knob to select desired frequency within selected range.	4. Desired frequency lines up with graticule on correct scale.
NOTE When the send section of the TTS-35 is switched between external frequency control (TTS-35XV) and internal control, the send level should be checked and readjusted as necessary.	

Table 4—26. TTS-35XDT Dial/Talk Adapter Operating Procedures

TEST SET-UP



SEND SECTION

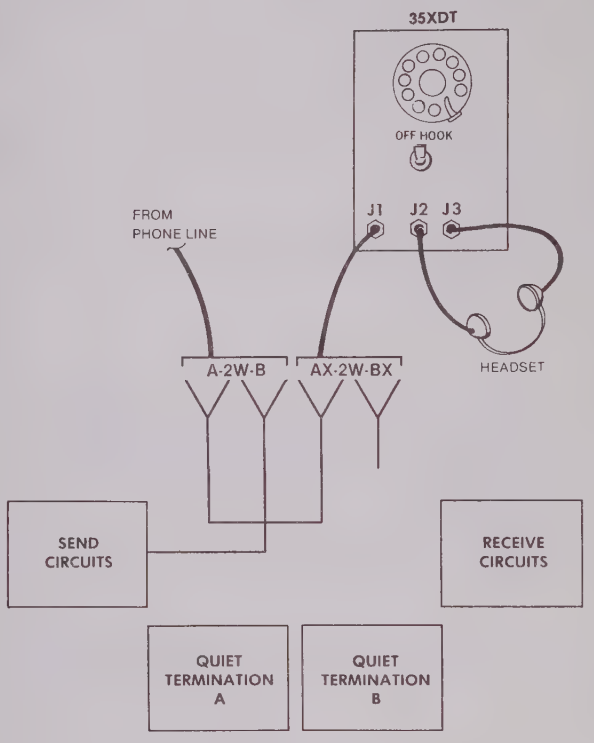
SEND FREQ. . . . . —
SEND ADJ . . . . . OFF
SEND LEVEL . . . . . —
SEND IMP & TERM A . . . . . 600Ω or 900Ω
LINE A HOMD . . . . . OFF

SWITCHING SECTION

POWER . . . . . OFF
LINE . . . . . REC A-SND B
FUNCTION . . . . . 2 WIRE (LA)
EXT CKT OR TEL SET . . AX ON A MEAS B

RECEIVE SECTION

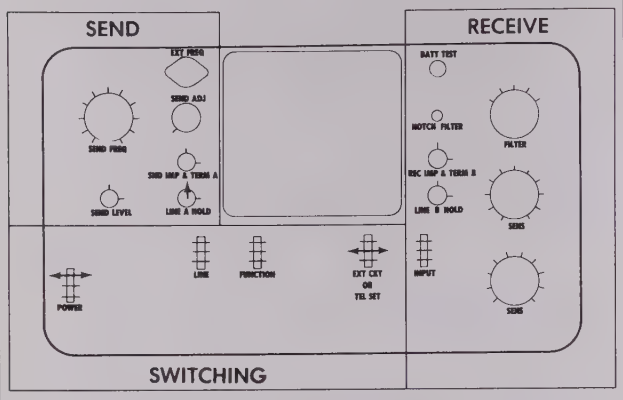
INPUT . . . . . TERM
LINE B HOLD . . . . . OFF
REC IMP & TERM B . . . . . 600Ω or 900Ω
NOTCH FILTER . . . . . OUT
FILTER 15KC
SENS . . . . . —
SENS . . . . . —



ACTION	RESULT
1. Position controls as shown above.	1. None
2. Connect headset to TTS-35XDT and connect test cords from phone line to A jack on TTS-35B and from J1 on TTS-35XDT to AX jack on TTS-35B.	2. Headset should be in a comfortable position.
3. At TTS-35XDT, set S1 to OFF-HOOK.	3. Hear dial tone.
4. Dial number of test line from TTS-35XDT.	4. Hear dialing followed by test tone (1 kHz, etc.).

Table 4—26. (cont'd)

MEASURE RECEIVED TONE

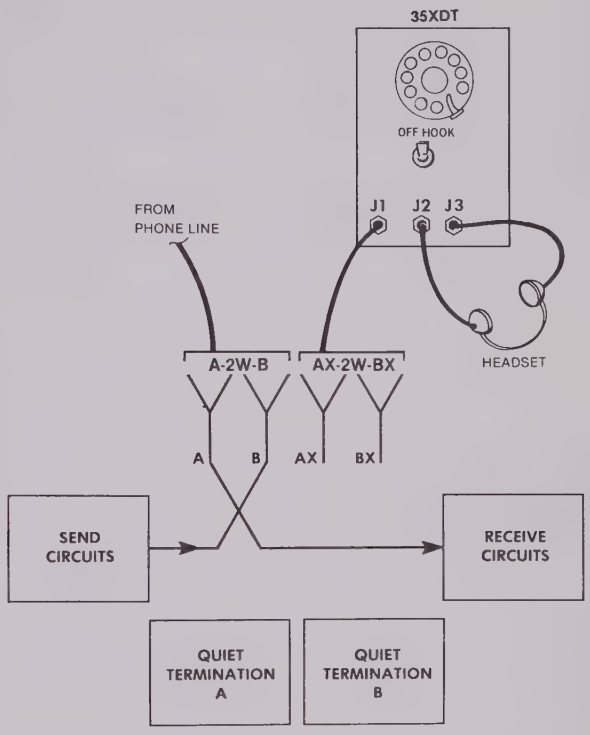


SEND SECTION

SEND FREQ	—	POWER	BATT
SEND ADJ	—	LINE	—
SEND LEVEL	—	FUNCTION	—
SEND IMP & TERM A	—	EXT CKT OR TEL SET	MEAS A AND B
LINE A HOLD	ON		

RECEIVE SECTION

INPUT	—
LINE B HOLD	—
REC IMP & TERM B	—
NOTCH FILTER	—
FILTER	—
SENS	As required
SENS	As required



ACTION	RESULT
5. Position controls as shown above. (Only **changes** in setting shown).	5. Meter needle deflects to test tone power level. No tone present in headset.
6. Adjust SENS switches S8 and S10 to obtain near zero scale reading.	6. Meter reads approximately 0 dB.
7. Place POWER switch OFF and disconnect test set-up.	7. Needle returns to left.

SECTION 5

THEORY OF OPERATION

5.1 This section describes the principles of operation. It includes a basic block diagram description and detailed circuit descriptions. The detailed descriptions are written with reference to a functional schematic diagram (Figure 7—1) showing all significant circuits and connections. Refer to Figure 7—1 in Section 7 while following the detailed analysis. The detailed schematic diagrams in Section 7 are arranged in the order of signal flow. Reference should be made to them and the functional schematic.

5.2 **BASIC BLOCK DIAGRAM DESCRIPTION (See Figure 5—1)**

5.3 The basic functional groups of the TTS-35 are shown in the block diagram, Figure 5—1. They consist of the front panel jacks and their associated switching circuits, the send circuits, hold coils for lines A and B, quiet terminations for lines A and B, and the voltage regulator circuits.

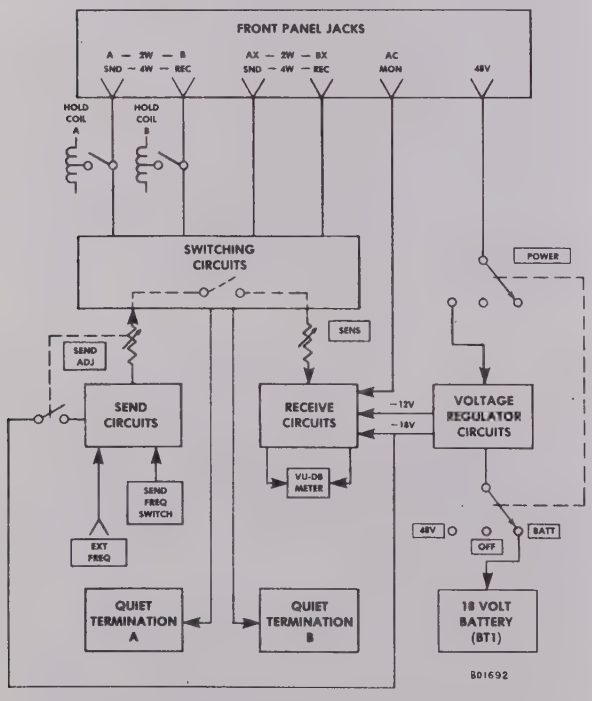


Figure 5—1. Block Diagram

5.4 SWITCHING CIRCUITS

5.5 Electrical connections between the send and receive circuits and the telephone circuits connected to front panel jacks A, B, AX and BX are controlled by the switching circuits. These circuits consist of the EXT CKT OR TEL SET switch, the LINE switch and the FUNCTION switch. Using these switches, the various combinations shown in Figures 4—8 and 4—9 may be made to accommodate any dial and telephone equipment to be used with the circuits under test.

5.6 SEND CIRCUITS

5.7 These circuits consist of a send oscillator and buffer and front panel controls for setting the output level and frequency. The SEND FREQ control is used to select any one of ten fixed audio frequencies. Variable frequencies may be selected if the optional TTS-35XV cover accessory is connected to the EXT FREQ connector. Output level is set with the SEND ADJ control. A switch on this control disconnects the —18 volt operating voltage from the send circuits to conserve battery power when the send circuits are not being used.

5.8 Audio signals are coupled through an output transformer to a send level and impedance matching network using the associated switches. A SEND LEVEL switch selects 0 or 10 dB output attenuation. Output impedance of 600 or 900 ohms is selected by the SEND IMP & TERM A switch.

5.9 This switch also connects line A to quiet termination A when the LINE switch is in the TERM position. This terminates line A with either 600 or 900 ohms plus a 2 microfarad capacitor to match the impedance of the telephone circuit being tested.

5.10 The output of the send circuits may be connected to the input of the receive circuits through the FUNCTION switch to set the send level on the VU-DB meter. The output level is unaffected by the SENS controls in the receive section during send level adjustments. They are used to keep the measurement signal on scale for the VU-DB meter.

5.11 RECEIVE CIRCUITS

5.12 Receive levels from the switching circuits are coupled to an impedance matching network through an input transformer. Input impedance of either 600 or 900 ohms may be selected for the transformer input or for quiet termination B by REC IMP & TERM B switch. The transformer output is connected to the FILTER switch via the INPUT switch. The INPUT switch may be used to connect the input to a noise ground or to substitute a bridge impedance for the 600 or 900 ohm termination.

5.13 Four different filter networks may be selected by the FILTER switch to provide the desired input frequency response for tone or noise measurements. In addition, a 1010 Hz notch filter may be used for noise-with-tone measurements. The four filters are described below.

1. **HI-PASS.** This filter attenuates low and high frequency energy present on the circuit under test below 200 Hz and above 10 kHz. It is used primarily to eliminate noise during tone measurements.

2. **15 KHZ.** The 15 kHz flat filter is used for unweighted measurements of tone or noise on radio and television studio transmitters and studio-remote audio links.

3. **C-MSG.** The C-message filter has a frequency response which simulates the effects of noise on the human ear as received on a type 500 headset. C-message weighting is used to evaluate noise on voice-grade circuits.

4. **3 KHZ.** The 3 kHz flat weighting filter is used for voice frequency circuits when investigating the effects of low frequency noise, such as power induction.

5.14 When using the black positions (LEVEL) of the FILTER switch, an average detector is used to measure tones. This circuit converts received signals into true rms values of direct current for display on the VU-DB meter. A tone amplifier is provided to monitor received signals at the AC MON jack.

5.15 When using the blue positions (NOISE) of the FILTER switch, a quasi-rms detector circuit is automatically selected. This circuit converts received noise signals into quasi-rms values for display on the VU-DB meter using the dBrn scale. This technique produces the same dc output for sinewaves and white noise having equal power levels. The AC MON jack on the front panel is also driven by another amplifier for the blue, noise positions of the FILTER switch.

5.16 Two sensitivity switches (SENS) are used to select predetermined attenuation levels to keep received signals within the measuring capabilities of the receive circuits and the VU-DB meter. The switch selectable 1010-Hz notch filter may be inserted between the two SENS switches to facilitate noise-with-tone measurements.

5.17 MEASUREMENT CAPABILITIES

5.18 Two types of measurements can be made with the TTS-35. The test set switches are color-coded with blue lettering for noise measurement positions and with black for tone measurements.

5.19 **Tone Measurements**

5.20 These measurements can be made over a dynamic range of +23 dBm to −95 dBm within the frequency range of the filter selected by the FILTER switch. The 200 Hz to 10 kHz hi-pass filter can be inserted to suppress low and high frequency energy or a 15 kHz filter may be used to attenuate tones above the audio band.

5.21 **Noise Measurements**

5.22 The three types of noise measurements available are: (1) metallic noise, (2) noise-with-tone, and (3) noise-to ground. They are described below.

1. **Metallic Noise.** Balanced, metallic noise is measured with both tip and ring isolated from earth ground. One of the three standard noise weighting filters may be used (see paragraph 5.13). Dynamic range for the metallic noise measurements is +113 to −5 dBrn for 600 and 900 ohm circuits.

2. **Noise-With-Tone.** These measurements show how much noise is present with a continuous data signal or the noise a listener would hear during a speech burst. In the noise-with-tone measurements, a sharp notch filter is switched into the receive section. The notch filter eliminates tones between 995 Hz and 1025 Hz which may be present on the circuit being tested. Measurement range is the same as for metallic noise measurements.

3. **Noise-To-Ground.** For these measurements, the difference in noise level between two sides of a balanced line and ground can be determined. The results are indicated between +113 dBrn and −5 dBrn; however, the actual measurements are 40 dB higher.

5.23 FUNCTIONAL SCHEMATIC DESCRIPTION (See Figure 7—1)

5.24 SEND CIRCUIT DETAILED DESCRIPTION

5.25 The send circuits may be separated into the oscillator circuits, the output circuits, and the input power circuits. Except for output transformer T2, the circuits are located on the Oscillator Board, PC3. The three circuits are described in the following paragraphs. Refer to Figure 7—24 for the schematic diagram of PC3.

5.26 Oscillator Circuits

5.27 This a bridged-T oscillator using transistors Q101-Q103. Positive feedback is provided from Q102 through tungsten bulbs RT1 and RT2 (not shown on Figure 7—1) and potentiometer R102 to Q101. FREQ ADJ R102 adjusts the positive feedback to provide stable operation. Negative feedback is normally greater than positive feedback and is provided to Q101 through a selective null network and emitter follower Q103. The selective bridged-T null network decreases the negative feedback enough to permit oscillation at the selected frequency.

5.28 For the front panel selected frequencies, the frequency is determined by two RC networks. The networks use fixed capacitors with different value resistors as selected from resistor network R101-R135 by SEND FREQ switch S14. Externally selected frequencies from the TTS-35XV cover accessory use the same RC networks; however, the resistors which determine the oscillator frequency are variable. This provides the tuneable frequency feature of the accessory. Connections are made to the TTS-35 via J7 on the front panel.

5.29 Buffer Amplifier Circuits

5.30 These circuits consist of a stage of voltage amplification (Q104) followed by output impedance matching provided by emitter follower Q105. The oscillator signal from Q102 is connected to Q104 through SEND ADJ control R101. This front panel control sets the output level between +3 and −40 dBm. The send output is taken from emitter follower Q105 and coupled to the primary of output transformer T2.

5.31 Output Circuits

5.32 The signal at the secondary of output transformer T2 is coupled to FUNCTION switch S4 via SEND LEVEL switch S15. Switching combinations for the send signal from the FUNCTION switch to the output front panel jacks are illustrated schematically in Figure 7—4 and pictorially in Figures 4—8 and 4—9.

5.33 The SEND LEVEL switch is used to insert one of two 10 dB pads in the oscillator output. SND IMP & TERM A switch S16 places resistor R173 or resistors R173 and R174 in series with the split secondary windings of T2 to provide an output impedance of 600 ohms or 900 ohms, respectively. It also selects R166-R168 for the 600 ohm 10 dB pad or R169-R171 for the 900 ohm pad to match the selected output impedance. Another section of S16 is used to match the quiet termination on CB2 with the selected output impedance for LINE A jack J1.

5.34 Input Power Circuits

5.35 The send circuits obtain −18 volts operating power via switch S13, which is part of the SEND ADJ control on the front panel. When POWER switch S12 is in the BATT position, −18 volts is applied directly to S13 from battery BT1. In the 48V position, external CO battery power is connected through −18 volt zener diode regulator circuit CR2 and R19 and then to switch S13. SEND ADJ switch S13 is normally left in the OFF position to conserve battery power when the send section is not being used.

5.36 RECEIVE CIRCUITS

5.37 The receive circuits may be separated into the sequential groups that process the incoming signal. The order of serial processing is as follows:

Title	Schematic Figure No.
1. Input Circuit	7—8
2. 10 dB Step Attenuator	7—10
3. 1010 Hz Notch Filter	7—12
4. Receive Amplifier 1 and Filter Network	7—14
5. 1 dB Step Attenuator	7—16
6. Receive Amplifier 2 and 3 Detector Switching Average Detector Voltage Regulator Circuit	7—18
7. Quasi-RMS Detector	7—20
8. Meter Circuit Tone Monitor Circuit Input Power Circuit	7—22

Note that the detailed schematic diagrams are arranged in signal flow order. Reference should be made to these diagrams and the functional schematic shown in Figure 7—1.

5.38 The overall gain of the receive circuits is provided by receive amplifier 1 (PC1), receive amplifier 2 and 3 (PC2) and either the average detector circuit on PC2 or the quasi-rms detector on PC4. Both amplifiers exhibit high gain stability by using large amounts of negative feedback. The inherent noise level of the receive section is at least −100 dBm and aproaches −120 dBm when the C-message filter is used.

5.39 The serial processing circuits listed above are described in the following paragraphs with reference to the functional schematic and the detailed schematics, as necessary.

5.40 **Input Circuit (See Figure 7—8)**

5.41 Input line connections are made to balanced transformer T1 via switches S3, S4 and S5 as shown in Figures 4—8, 4—9 and 7—4. DC blocking capacitors in the primary circuit of T2 can withstand 150 volts dc of either polarity.

5.42 INPUT switch S7 allows one of three terminations to be provided as follows:

1. 600 or 900 ohm termination.
2. Bridged termination across the line.
3. Noise-to-ground termination.

In the TERM position, resistors for either 600 or 900 ohm input impedances may be switched directly across the input line by REC IMP & TERM B switch S6. The termination resistors are switched at the equal potential point (center tap of T1). This maintains a balance of at least 80 dB at 60 Hz, 70 dB at 1000 Hz and better than 60 dB up to 10 kHz. Another section of S6 adjusts quiet termination B for LINE B jack J2 to match the selected input impedance of 600 or 900 ohms. Selection of the quiet termination is determined by LINE switch S3.

5.43 With INPUT switch S7 in the BRDG position, the reflected impedance of 1:1 transformer T1 is placed across the line. Since the secondary of T1 is loaded by a high impedance, the primary also reflects a high impedance. Impedances are nominally 12,000 ohms for 600 ohm circuits and 15,000 ohms for 900 ohm circuits. Losses for bridge terminations are less than 0.2 dB for frequencies down to approximately 100 Hz.

5.44 In the N-GND position of INPUT switch S7, a longitudinal drain is provided with the center tap connected to ground through resistor R7. This allows noise-to-ground measurements to be made.

5.45 **10 dB Step Attenuator (See Figure 7—10)**

5.46 SENS switch S8, a three section attenuator, provides sensitivity adjustments in 10 dB steps from +20 dB to −70 dB. In the last switch section, 30 dB is available in 10 dB steps from a tapped voltage divider consisting of resistors R601, R602, R603, R604 and R609. Two other sections consisting of resistors R605/R607 with 30 dB loss and R606/R608 with 30 dB loss may be switched ahead of the 10 dB attenuator section.

5.47 For the first 30 dB of loss, (positions −60, −50, −40 dB), only the tapped voltage divider consisting of R601, R602, R603, and R604 is used. For the −30 dB position of SENS switch S8, a single 30 dB section consisting of R605/R607 is placed ahead of the tapped voltage divider and 10 dB loss is added to the output section by R603. Thus, the tapped divider is used for the 10 dB steps and the other two 30 dB sections are switched in as necessary to extend the range of the 10 dB steps. To assure an attenuation accuracy of 0.15 dB, resistors with ½% tolerances are used. Table 5—1 summarizes the various resistor combinations for all switch positions.

Table 5—1. 10 dB Attenuator S8 Resistor Combinations

POSITION (dB)	INSERTION LOSS (dB)	R603 (10 dB)	R602 (10 dB)	R601 (10 dB)	R605 & R607 (30 dB)	R606 & R608 (30 dB)
−70	none					
−60	−10	X				
−50	−20	X	X			
−40	−30	X	X	X		
−30	−40	X			X	
−20	−50	X	X		X	
−10	−60	X	X	X	X	
0	−70	X			X	X
+10	−80	X	X		X	X
+20	−90	X	X	X	X	X

5.48 **1010 Hz Notch Filter (See Figure 7—12)**

5.49 The passive notch filter may be inserted into the receive circuits using NOTCH FILTER switch S17.

NOTE

The receive section of the TTS-35 is shut off if NOTCH FILTER switch S17 is in the IN position and FILTER switch S9 is in either of the black LEVEL positions. This prevents making erroneous measurements of a 1000 Hz tone with the 1010 Hz filter enabled.

The filter is inserted between the 10 dB attenuator S8 and receive amplifier 1 (PC1). It may be used with any of the three noise filters selected by FILTER switch S9. As noted above, the receive section is intentionally shut off if an attempt is made to use the notch filter in conjunction with the tone (LEVEL) filters.

5.50 The notch filter provides at least 50 dB rejection from 995 to 1025 Hz and allows noise to be measured in the presence of tone. Refer to Section 2, Specifications, for the frequency response curve. This band-reject filter has 600 ohm input and output impedances. Amplifier U1 operates at unity gain and provides the required high input impedance. Transistors Q1 and Q2 supply sufficient gain to compensate for the insertion loss of the passive filter assembly. Potentiometer R9 sets the gain. Transistor Q3 is an emitter follower-type voltage regulator that keeps input voltage variations from affecting the gain of the amplifier stages.

5.51 **Receive Amplifier 1 (See Figure 7—14)**

5.52 This is a two stage voltage amplifier (Q102 and Q103) with negative feedback. Since the amplifier drives the filter sections, emitter follower Q104 in the output stage provides the necessary impedance matching. It isolates the filter input impedances from amplifier Q103. The emitter current of Q104 is returned through R106. This resistor is common to the emitter of Q102 and provides negative feedback. Approximately 30 dB of feedback is provided over the entire band of frequencies.

5.53 A diode in the emitter circuit of Q104 compensates for input voltage variations. If the voltage decreases, the emitter current of Q104 also decreases. This raises the impedance of the diode which decreases the negative feedback slightly and keeps the overall gain of the TTS-35 relatively independent of supply voltage variations.

5.54 The emitter of Q104 supplies the output through an RC network that blocks dc and voltage switching transients from the following stages. The nominal output impedance of receive amplifier 1 is 5 ohms. Series resistor R110 in the output matches the 5 ohm impedance to the filter's 600 ohm characteristic impedance.

5.55 **Filter Switching Network (See Figure 7—14)**

5.56 This network consists of FILTER switch S9, a 7-pole, 5-position rotary switch, and associated resistors, capacitors and inductors. Figure 7—14 is separated into the four filter circuits, showing the active components for each of the five switch positions. For filter characteristics, refer to Section 2, Specifications. Note that the same filter is used for both 15KC positions of FILTER switch S9. Most of the electrical components of the filters are located on receive amplifier 1 (PC1). Resistors and capacitors shown shaded on Figure 7—14 are located on FILTER switch S9.

5.57 **1 dB Step Attenuator (See Figure 7—16)**

5.58 This network consists of SENS switch S10 and resistors R501 through R511. It is a conventional stepped voltage divider that presents a 600 ohm input impedance to the filter networks and is terminated by the high impedance of receive amplifier 2. This attenuation network provides a 10 dB range of attenuation in 1 dB steps using 10 resistors (R501-R510) plus resistor R511. In the 0 dB position, all 10 resistors are used. Attenuation is removed 1 dB at a time for each decreasing switch position until at the −10 dB position, all 10 resistors are by-passed. To insure 0.15 dB attenuation accuracy, resistors with 1% tolerance are used.

5.59 **Receive Amplifier 2 (See Figure 7—18)**

5.60 This amplifier is located on PC board 2 along with the average detector, output monitor amplifier, and −12 volt regulator. Transistors Q201, Q202 and Q203 are conventional, common emitter amplifiers with collector to base bias. The last stage (Q203) uses a 4.3K ohm emitter resistor. This relatively large dc resistance provides the bias for direct coupled amplifiers Q202 and Q203 so that degeneration at signal frequencies does not occur in this stage. The unbypassed part of the emitter is 50 ohm resistor R209. This resistor provides overall loop feedback to Q201 in order to stabilize the gain of receive amplifier 2. The output from Q203 is applied to either the average detector or the quasi-rms detector via FILTER switch S9.

5.61 **Detector Switching (See Figure 7—18)**

5.62 Two decks of FILTER switch S9 are used to switch either the average detector or the quasi-rms detector into the receive circuit. When the FILTER switch is in either of the first two black positions, the output of receive amplifier 2 is connected to the input of the average detector through S9-6B. The output of the average detector is connected through switch sections S-9A and B to the VU-DB meter M1 via BATT TEST switch S11.

5.63 With FILTER switch S9 in any of the last three blue positions, the output of receive amplifier 2 is connected to the input of the quasi-rms detector via S9-6B. to the VU-DB meter via the BATT TEST switch.

5.64 **Average Detector (See Figure 7—18)**

5.65 This detector is comprised of Q301, Q302 and a full wave diode bridge network. The output of Q302 is applied to the diode bridge and then returned to the emitter of Q301 to supply negative feedback. Potentiometer R308 in the emitter circuit of Q301 provides gain adjustment for the average detector. When the signal at Q302 is on the negative half-cycle, CR301 conducts and the signal goes through meter M1 and CR304 back to Q301. When the Q302 output goes positive, the path of conduction is through CR302, meter M1, CR303 and back to Q301. Since the ballistics of the meter causes the peaks to be ignored, it responds to the average values of dc.

5.66 The meter is calibrated so that average values are indicated as rms values. The characteristics of such a circuit linearizes the resistance of the bridge diodes. For example, if the resistance of the diodes increases due to temperature changes, or decreased meter current, the feedback is automatically adjusted so that the meter current is a linear function of the input voltage. This is true for wide ranges of temperature and for mismatched diodes. Thus, the circuit is relatively unaffected by component values or voltage/current changes.

5.67 **Quasi-RMS Detector (See Figure 7—20)**

5.68 This detector is on printed circuit board PC4. The noise input is amplified by two-stage common emitter amplifiers Q1 and Q4. Bootstrap amplifier Q2 provides isolation for the two-stage amplifier by increasing the impedance at the collector of Q4. Transistors Q3/Q6 and Q5/Q7 form a full wave rectifier circuit which converts the noise signal to quasi-rms current for measurement by VU-DB meter M1.

5.69 Overall sensitivity of the detector is −20 dB. Capacitors C7 and C8 combine the rectified output to provide an audible signal at AC MON jack J6 via tone monitor amplifier Q8 and GAIN adjust R17. Note that the collector operating voltage for Q8 is provided only when a plug is inserted into jack J6. It comes from the

−18 volt supply and resistor R310. This feature conserves battery power when the AC MON jack is not being used.

5.70 **Meter Circuit (See Figure 7—22)**

5.71 Meter M1 is used for battery tests as well as level and noise measurements of signals received from the average detector or the quasi-rms detector. BATT TEST switch S11 disconnects the meter from the detectors and connects −18 volts to the meter from voltage regulator circuits U1, Q1 and Q2. A green arc marked GOOD is provided on the meter to indicate battery condition.

5.72 **Tone Monitor Circuits**

5.73 These circuits consist of amplifier Q303 on PC2 for the average detector and amplifier Q8 on PC4 for the quasi-rms detector. The signal from the detector selected by FILTER switch S9 is amplified and applied to AC MON jack J6. As described previously, the collector voltage for Q303 or Q8 is disconnected until a plug is inserted in jack J6 to conserve battery power. The input impedance of both tone monitor amplifiers is high and does not affect the amount of feedback or the gain of either detector.

5.74 Ths signal at the AC MON jack is dc blocked so that a resistance such as a headset or recording device may be inserted between the tip and ring. The output level is 10 dBm less than indicated on the meter regardless or the setting of SENS switches S8 and S10. Since the meter scale is calibrated from −15 dBm to +3 dBm, the monitor signal is in the range of −25 dBm to −7 dBm. For example, when the meter indicates 0 dBm, the monitor output is −10 dBm. Frequency response is −3 dB at 100 Hz and 15 kHz for the flat 15KC position of FILTER switch S9. For the other three positions of S9, the response is the same as the meter. Signal-to-noise ratio is greater than 30 dB fro meter readings of at least −3 dBm.

5.75 **Power Circuits**

5.76 The TTS-35 operates from one of two power sources. Either the internal 18 volt batteries or an external source of −48 volts may be used. When operating from a −48 volt source, the internal battery is disconnected by POWER switch S12 and the −48 volts is applied to 18 volt zener diode CR3 through R10. The output from CR3 is applied to voltage regulator U1, Q1 and Q2 to provide −12 and −18 volt power to the receive section. The send section receives power from across zener diode CR2 and R19. This −18 volts is applied through the SEND ADJ switch S13 to the send section.

5.77 The −18 volts across CR3 is applied to regulator U1, Q1 and Q2 through FILTER switch S9 and NOTCH FILTER switch S17. If S17 is in the IN position and S9 is in either of the first two black positions (LEVEL), power to the receive section is disconnected to prevent erroneous tone measurements with the notch filter selected.

5.78 **Voltage Regulator Circuit**

5.79 The −18 volts supplied from CR3 is applied to −12 volt voltage regulator U1, Q1 and Q2. This is a simple series pass regulator. A zener diode (CR1) provides a reference of 5.6 volts that is applied to the non-inverting input of operational amplifier U1. The ratio of resistors R3 and R4 sets the regulated output voltage at approximately −12 volts. Series pass element Q1 provides the current gain to supply the required output current. Transistor Q2 and resistor R2 limit the output current to a safe level.

5.80 **TTS-35 ACCESSORIES, CIRCUIT DESCRIPTIONS**

5.81 TTS-35XDT DIAL AND TALK ADAPTER (See Figure 7—25)

5.82 This accessory contains standard telephone dial and talk circuits. Talk/listen connections are made to a 52A-type headset via J2 and J3.

5.83 TTS-35XPS AC POWER SUPPLY ADAPTER (See Figure 7—27)

5.84 Transformer T1 steps down the input ac voltage to approximately 35 Vac. This voltage is rectified by full wave bridge rectifier diodes CR1 through CR4. The RC network consisting of R1/R2 and C1/C2 doubles the voltage to approximately 70 volts dc under no-load conditions. With the TTS-35 connected to the 48V connector J1, the output voltage stabilizes at 45 volts dc (loaded). The input and output circuits are protected by fuses F1 (0.5 amps) and F2 (0.2 amps). By adding resistor R220 in the primary circuit of T1, the TTS-35XPS may be used with a 220 Vac input power source.

5.85 TTS-35XV CONTINUOUSLY VARIABLE FREQUENCY ADAPTER (See Figure 7—30)

5.86 Ganged potentiometer R1A and R1B are mechanically coupled to the SCALE control. They provide the variable frequency determining network for the send oscillator in the TTS-35. Potentiometers R2/R5, R3/R6 and R4/R7 provide the three range controls and are calibrated in pairs to insure amplitude and frequency tracking throughout the three ranges. Capacitors C1 through C6 are fixed attenuation pads for the high and low ends of each frequency range.

SECTION 6

MAINTENANCE

6.1 This section provides instructions for maintaining the TTS-35 Series test sets. No routine preventative maintenance is required other than normal cleaning procedures. Procedures are included in this section for replacing the 12 D cells in the bottom of the case assembly and for calibrating the send and receive sections. Brief troubleshooting hints are also provided.

6.2 REPLACEMENT OF INTERNAL D CELLS

6.3 Refer to paragraph 4.13 and perform the battery test procedures. If the meter needle indicates below the GOOD arc, replace all twelve D cells as follows:

1. Place POWER switch OFF.

2. Turn the test set upside down and rest it on a workbench.

3. Remove the six screws and washers that attach the bottom cover to the case.

4. Gently pry cover from case to expose internal D cells.

5. Remove all 12 D cells.

6. Install 12 new D cells. Observe correct polarities as marked on the cell holders to place all cells in series with each other.

7. Place POWER switch to BATT and repeat BATT TEST procedure in paragraph 4.13 to insure new cells are satisfactory.

8. Install the bottom cover to the case with the six screws removed in step 3.

6.4 TROUBLESHOOTING HINTS

6.5 Problems that may at first appear to be the result of a hardware failure may simply be caused by the operational characteristics of the unit. Listed below are some of the common operator errors and test set constraints that should be checked prior to assuming that a hardware failure exists.

1. Check power source with BATT TEST switch (paragraph 4.13).

2. Check switch settings (Figures 4—8 and 4—9).

3. Check input/output jack connections.

4. Check condition of test cords, plugs and associated equipment for worn or frayed connections, dirty or corroded contacts or other high resistance conditions.

5. Be certain that NOTCH FILTER switch is in the OUT position when FILTER switch is in either black position (15 KC or HI-PASS).

6. Check that SND ADJ calibration is performed only when FILTER switch is in either of the two 15KC positions.

7. Check that SND and REC impedances are the same when applicable.

8. Be sure to add the setting of the SEND LEVEL switch to the SENS switches and meter reading.

9. Check accuracy of meter needle mechanical zero position (paragraph 4.10)

10. Use AC MON jack and headphones to verify presence of received signals.

6.6 TEST EQUIPMENT REQUIRED

6.7 Table 6—1 lists the test equipment required to perform the calibration procedures. Equivalent equipment may be substituted for the specified types.

6.8 CALIBRATION

6.9 Calibration procedures are separated into the receive section and the send section. The receive section is calibrated first using an external frequency source as a standard. The send section is then calibrated, and its output frequency is checked with a frequency counter. Table 6—2 summarizes the order of calibration and associated adjustments.

Table 6—1. Test Equipment

ITEM	MODEL (or equivalent)	USE
AC Voltmeter	HP 400FL	Measure input/output levels (dBm into 600 ohms)
Signal Generator	HP 204D	Provide 1010 Hz and 1700 Hz tones at 0 dBm for receive section calibration.
Oscilloscope	Tektronix 475	To observe send section output sinewave.
Frequency Counter	HP 5328	To measure tone output of send section and to set output frequency of signal generator.
Precision Load	600 ohms, 0.1%, ¼ watt	Simulate output impedance.
Test Cord	Western Electric 2W6A	Connects TTS-35 jacks to test equipment using a 310 plug on one end and two 59 cord tips on the other end.

Table 6—2. Calibration Summary

ADJUSTMENT	LOCATION	CIRCUIT	SPECIFICATION
R308 (Gain)	PC2	Average Detector	0 dBm ± 0.1 dB
R17 (Gain)	PC4	QRMS Detector	0 dBm ±0.1 dB
R9 (Gain)	PC5	Notch Filter	Greater than −50 dBm at 1010 Hz ± 10 Hz
R102 (Level)	PC3	Send Oscillator	1.55 Vrms at C150
Selected Capacitors C152 and C153	PC3	Send Oscillator	1000 Hz ± 2%

6.10 RECEIVE SECTION CALIBRATION (See Figures 6—1 and 6—2)

6.11 This calibration consists of applying a 1000 Hz, 1 milliwatt signal to the receive section with the FILTER switch in the 15KC tone position. The average detector is then adjusted as necessary to provide a 0 dBm indication on the meter. The procedure is repeated with the FILTER switch in the C-MSG noise position which switches in the quasi-rms detector. This detector is similarly adjusted for 0 dBm on the meter. Both of these steps are done with the NOTCH FILTER switch in the OUT position.

6.12 After both detectors are calibrated, the NOTCH FILTER is switched to IN with the C-MSG filter also selected. A 1700 Hz tone is applied and the notch filter is adjusted as necessary to provide 0 dBm on the meter. This tone is between the limits for both filters. Finally, a 1010 Hz signal is applied and the notch filter is checked for an attenuation of at least 50 dB.

6.13 The specific steps for calibrating the receive section are listed in Table 6—3. Perform them in sequence shown with reference to Figures 6—1 and 6—2.

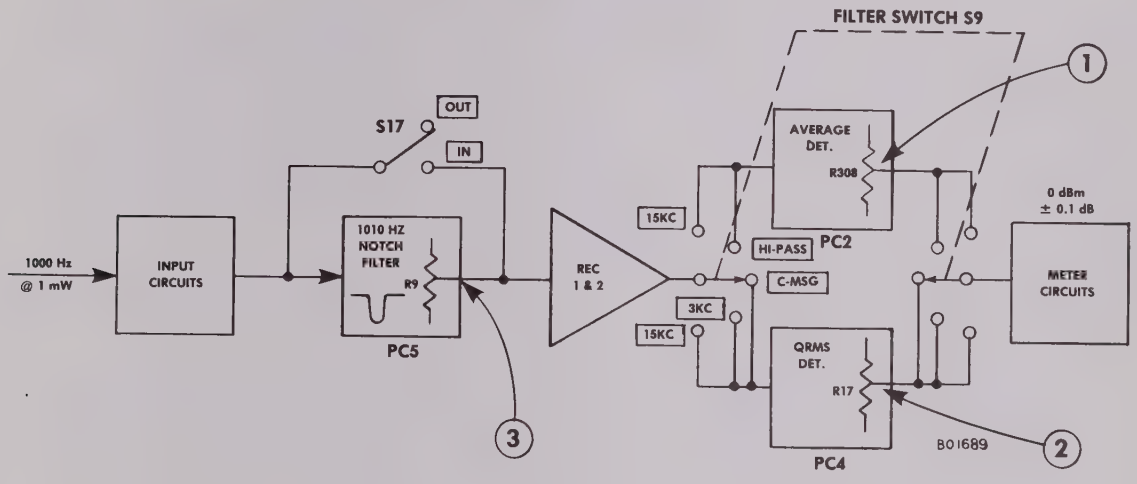


Figure 6—1. Receive Circuits Adjustments

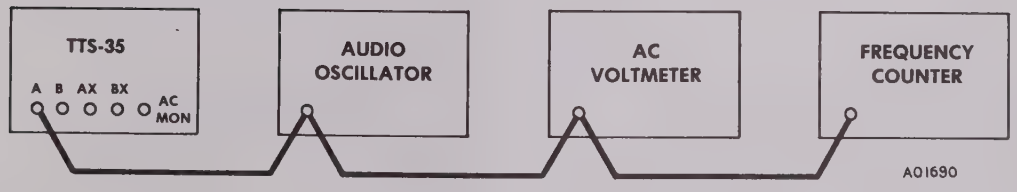
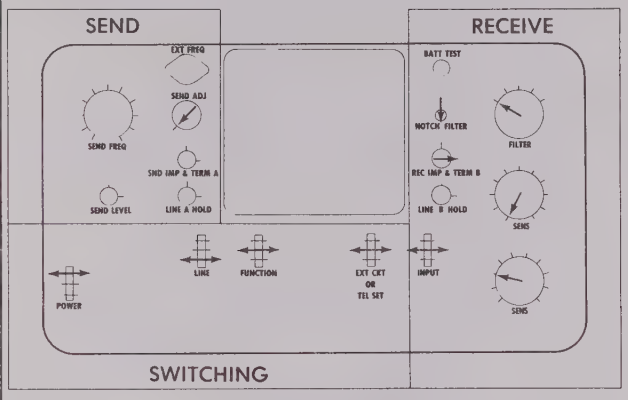
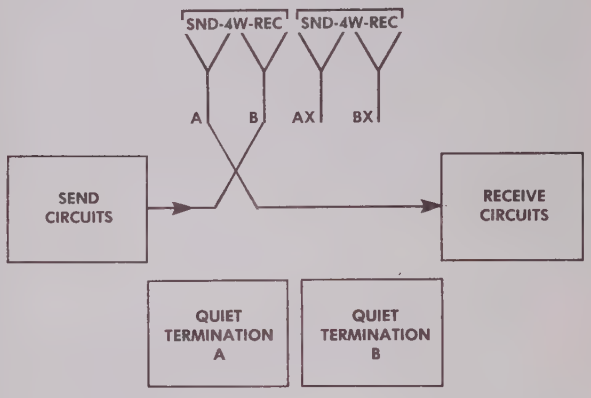


Figure 6—2. Receive Circuits Test Set-Up

Table 6—3. Receive Section Calibration

TEST SET-UP





SEND SECTION

SEND FREQ. . . . . —
SEND ADJ . . . . . **OFF**
SEND LEVEL . . . . . —
SEND IMP & TERM A . . . . . —
LINE A HOLD . . . . . —

SWITCHING SECTION

POWER . . . . . **BATT**
LINE . . . . . **REC A-SND B**
FUNCTION . . . . . **2 WIRE (LA)**
EXT CKT OR TEL SET . . . . **MEAS A AND B**

RECEIVE SECTION

INPUT . . . . . **TERM**
LINE B HOLD . . . . . **OFF**
REC IMP & TERM B . . . . . **600 Ω**
NOTCH FILTER . . . . . **OUT**
FILTER . . . . . **15KC (black)**
SENS **0**
SENS **0**

ACTION	RESULT
AVERAGE DETECTOR	
1. Position controls as shown above.	1. Meter needle may deflect.
2. Connect test equipment as shown in Figure 6—2.	2. None
3. Connect signal generator (audio oscillator) to front panel jack A.	3. None
4. Set signal generator to 1000 Hz at 1 milliwatt. .7745 VAC	4. AC voltmeter indicates 1 milliwatt and frequency counter indicates 1000 Hz.
5. Observe meter M1 on TTS-35. If average detector output is not within ± 0.1 dB, remove TTS-35 from case and adjust R308 on receive amplifier 2 (PC2) as required.	5. Meter should indicate 0 dBm ± 0.1 dB.

Table 6—3. (cont'd)

ACTION	RESULT
QRMS DETECTOR	
6. Place FILTER switch to blue 15KC (last position).	6. Meter needle may change.
7. Observe meter M1 on TTS-35. If quasi-rms detector output is not within ± 0.1 dB, remove TTS-35 from case and adjust R17 on QRMS detector (PC4) as required.	7. Meter should indicate 0 dBm ± 0.1 dB.
NOTCH FILTER	
8. Set signal generator to 1700 Hz at 1 milliwatt.	8. AC voltmeter indicates 1 milliwatt and frequency counter indicates 1700 Hz.
9. Place NOTCH FILTER switch to IN position. If notch filter output is not within ± 0.1 dB, remove TTS-35 from case and adjust R9 on notch filter (CP5) as required.	9. Meter should indicate 0 dBm ± 0.1 dB.
10. Set signal generator to 1010 Hz at 1 milliwatt.	10. AC voltmeter indicates 1 milliwatt and frequency counter indicates 1010 Hz.
11. Set lower SENS switch to −50 on black scale and observe meter M1.	11. Meter should indicate less than 0.

6.14 SEND SECTION CALIBRATION (See Figures 6—3 and 6—4)

6.15 This calibration consists of connecting an ac voltmeter to the output of the send section and adjusting SEND ADJ control on the front panel to obtain a 0 dBm signal at 1000 Hz on the ac voltmeter. The FUNCTION switch is then changed to the SND ADJ position which connects the send section to the receive section. If VU-DB meter M1 does not indicate within ±0.1 dB, the ac voltmeter is connected directly to the send oscillator and its output is adjusted to obtain 1.55 Vrms on the ac voltmeter. This calibrates the send oscillator with meter M1.

6.16 Frequency calibration of the TTS-35 is normally not done except at the factory or at a repair facility. Tolerance on output frequency is ±2%. If a failure occurs, or the frequency is out of tolerance, capacitors C152-C155 are changed as required to obtain the specified output frequency.

6.17 Specific steps for calibrating the send section are listed in Table 6—4. Perform them in the sequence shown with reference to Figures 6—3 and 6—4.

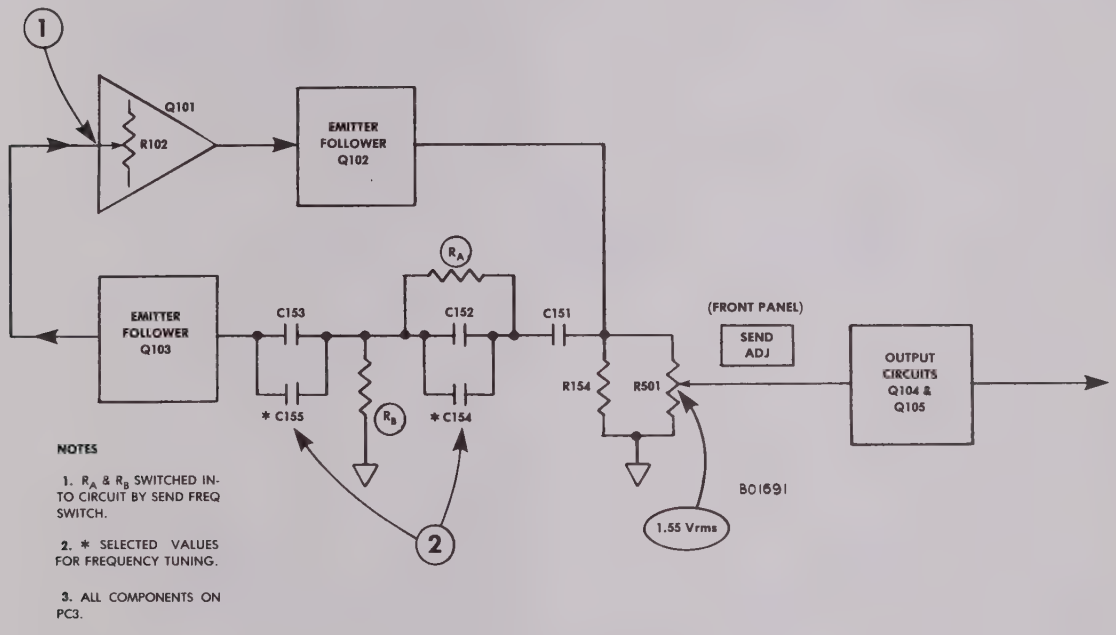


Figure 6—3. Send Circuits Adjustments

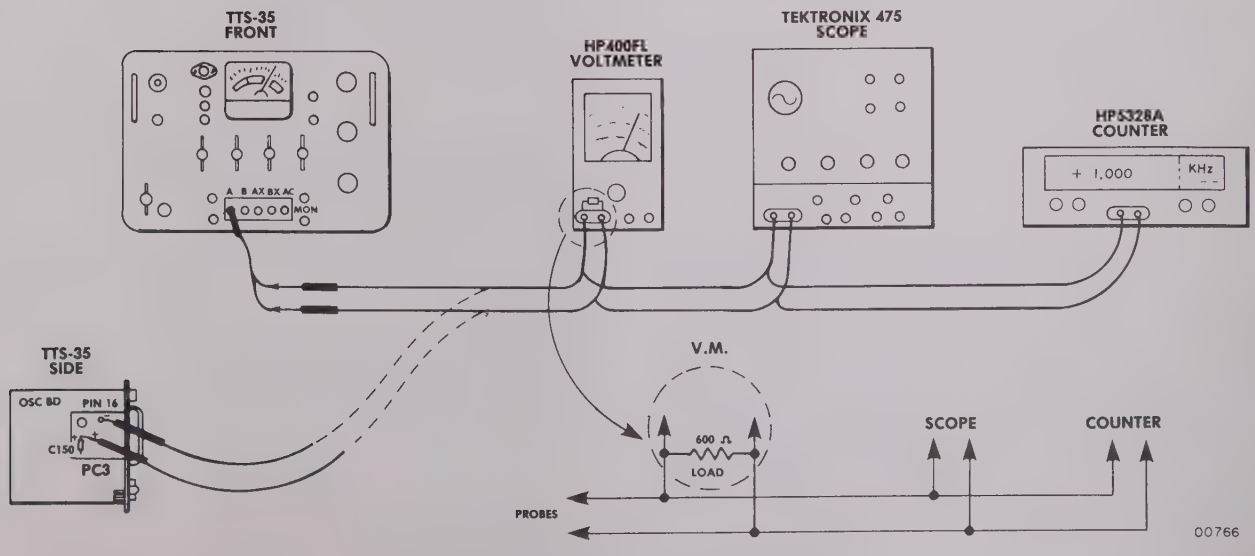
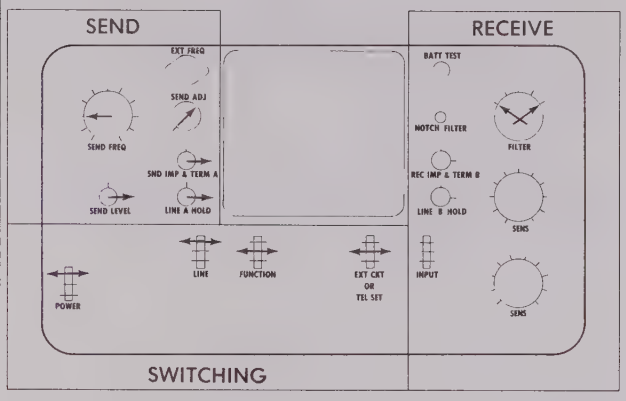


Figure 6—4. Send Circuits Test Set-Up

Table 6—4. Send Section Calibration

TEST SET-UP



SEND SECTION

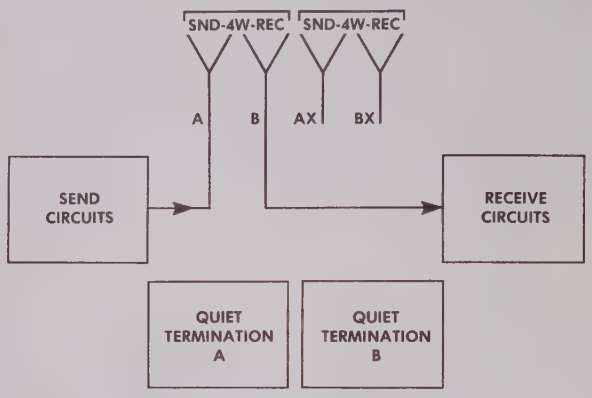
SEND FREQ ..... **CAL 1000**
SEND ADJ ..... **ON**
SEND LEVEL **0**
SEND IMP & TERM A **600Ω**
LINE A HOLD ..... **OFF**

SWITCHING SECTION

POWER ..... **BATT**
LINE ..... **SND A-REC B**
FUNCTION ..... **2 WIRE (LA)**
EXT CKT OR TEL SET .... **MEAS A AND B**

RECEIVE SECTION

INPUT ..... —
LINE B HOLD ..... —
REC IMP & TERM B ..... —
NOTCH FILTER ..... —
FILTER **15KC**
SENS ..... —
SENS ..... —



ACTION	RESULT
1. Position controls as shown above.	1. Meter needle may deflect.
2. Connect test equipment as shown in Figure 6—4.	2. None
3. Connect 600 ohm resistor across ac voltmeter output terminals and connect voltmeter to front panel jack A on TTS-35.	3. None
4. Set SEND ADJ control to obtain 0 dB on ac voltmeter.	4. AC voltmeter indicates 0 dB, oscilloscope displays a clean sinewave and frequency counter indicates 1000 Hz ± 20 Hz.
5. Place FUNCTION switch to SND ADJ position. Insure FILTER switch is in one of the two 15KC positions.	5. VU-DB meter on TTS-35 should indicate 0 dBm ± 0.1 dBm.
6. If VU-DB meter does not indicate ± 0.1 dBm, remove TTS-35 from case, connect ac voltmeter to positive end of capacitor C150 (junction of C150 and C151) on oscillator board (PC3) and adjust R102 to obtain 1.55 Vrms on ac voltmeter. Refer to Figure 7—23 or parts location. (Remove 600 ohm resistor from ac voltmeter).	6. Unloaded ac voltmeter indicates 1.55 Vrms.

Table 6—4. (cont'd)

ACTION	RESULT
7. Repeat steps 4 and 5 with loaded ac voltmeter connected to A jack. NOTE Observe correct scope lead polarities to prevent loading of the send oscillator.	7. Loaded ac voltmeter should indicate 0 dB in step 4 and VU-DB meter should indicate 0 dBm ± 0.1 dBm in step 5.

SECTION 7

DIAGRAMS

7.1 This section contains functional, interconnection, schematic and parts location diagrams for the TTS-35 Series test sets and accessories.

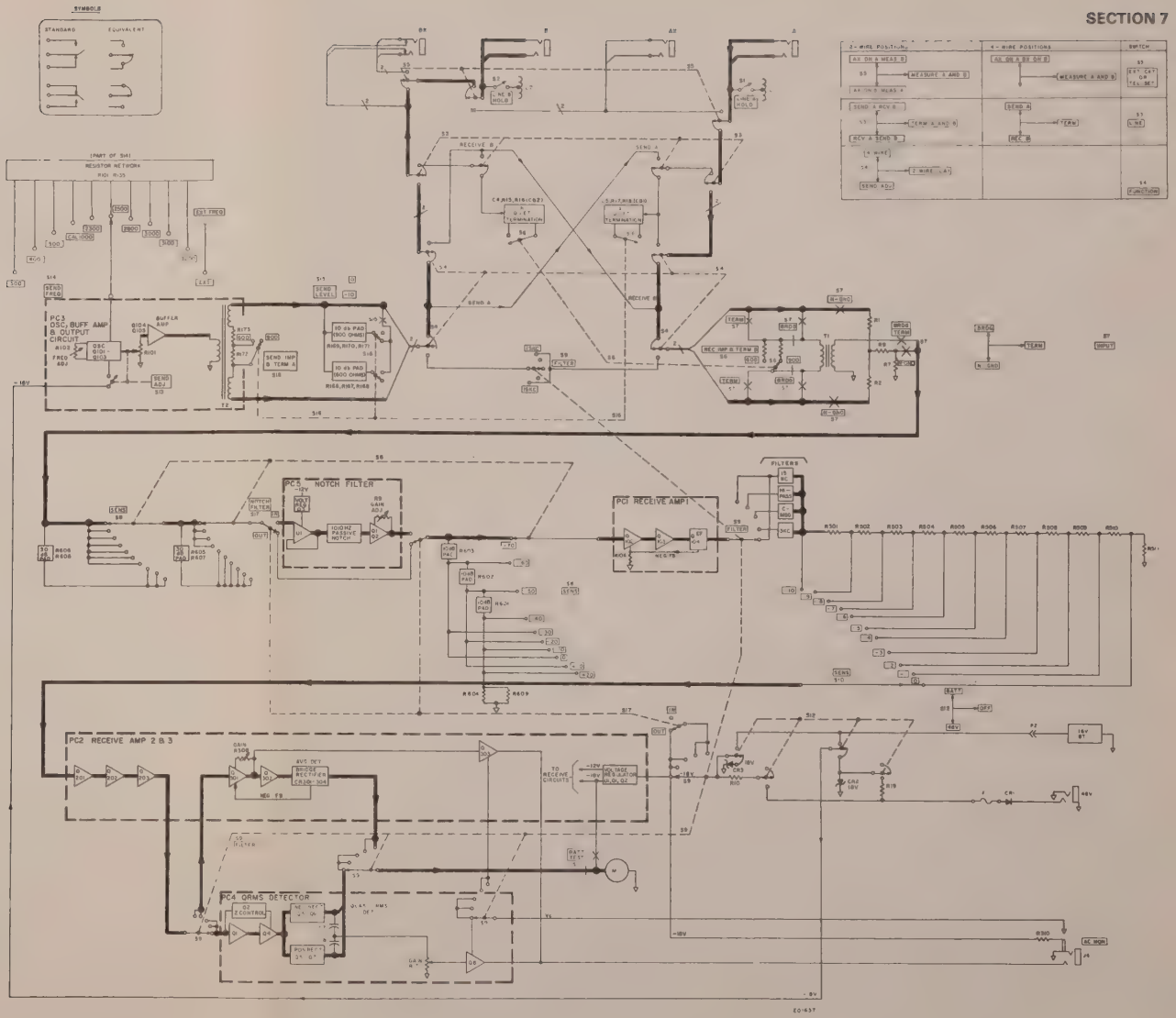


Figure 7—1. Functional Schematic Diagram

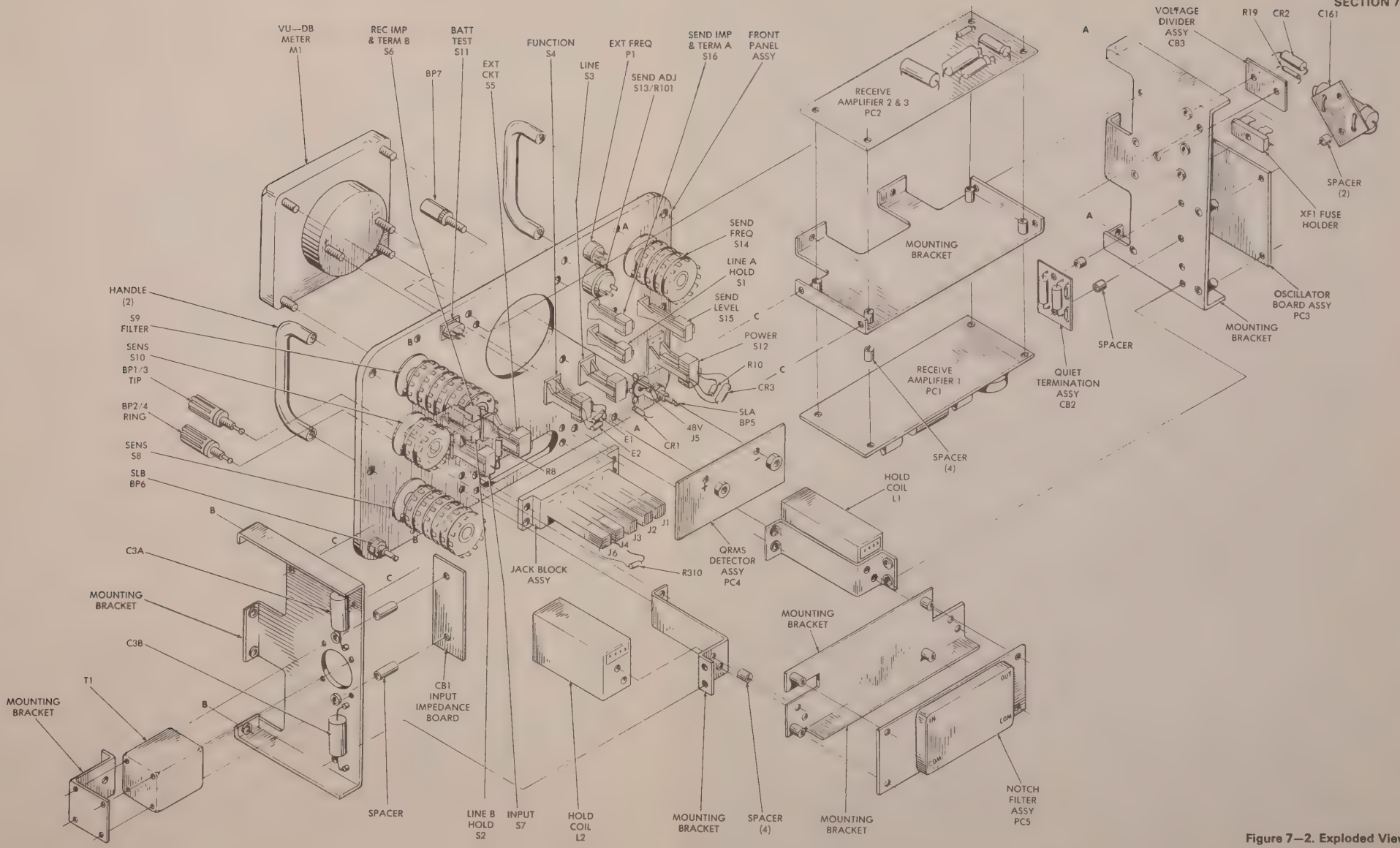


Figure 7—2. Exploded View

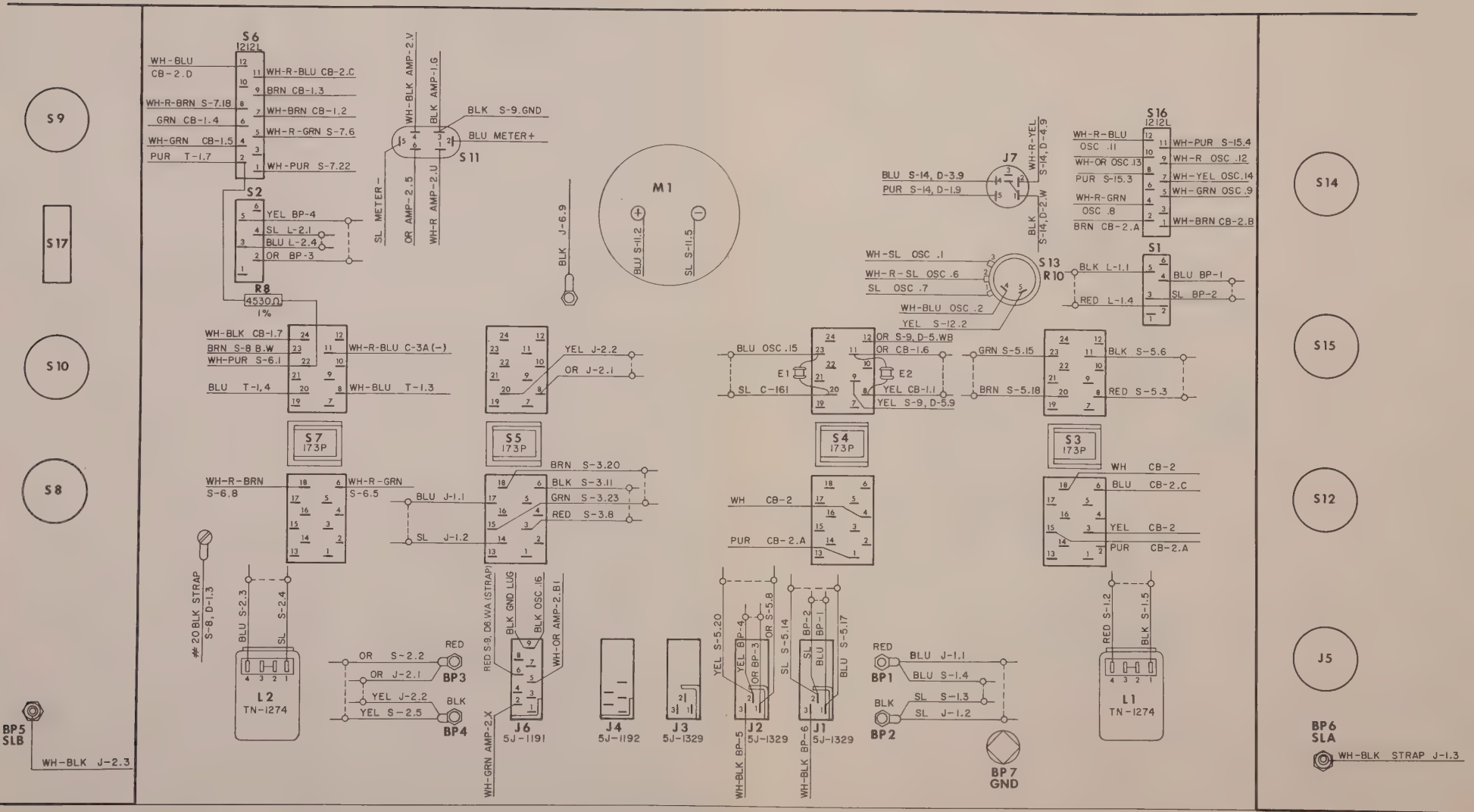
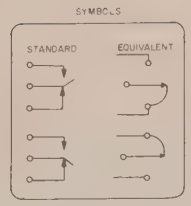


Figure 7—3. Practical Wiring Diagram



4-WIRE POSITIONS	2-WIRE POSITIONS	SWITCH
AX ON A BX ON B MEAS A & B	AX ON A MEAS B MEASURE A & B AX ON B MEAS A	S5 EXT KT OR TEL SET
SND A TERM REC B	SEND A RCV B TERM A & B RVC A SEND B	S3 LINE
	4-WIRE 2-WIRE (LA) SEND ADJ	S4 FUNCTION
	BRDG TERM N GND	S7 INPUT

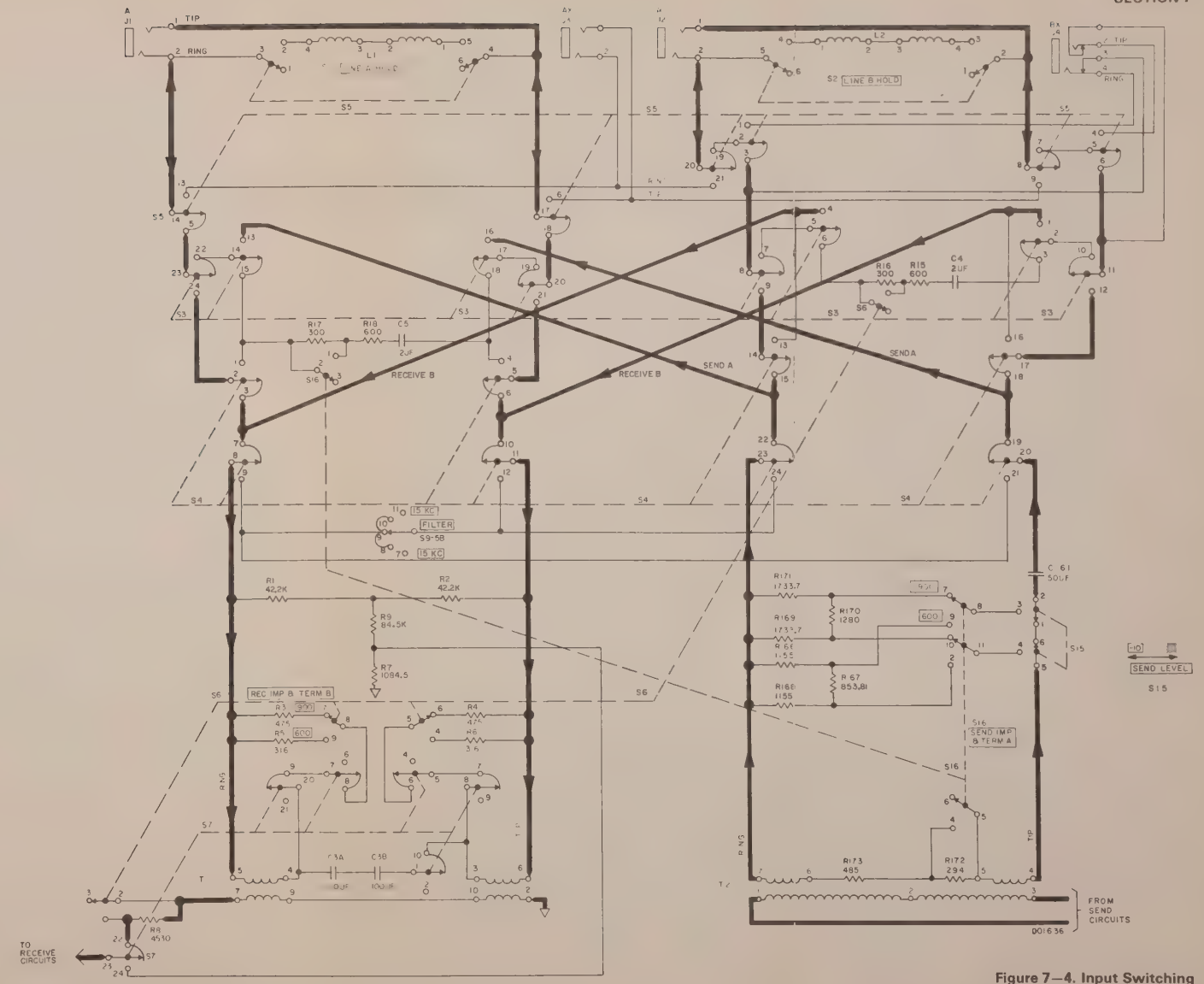
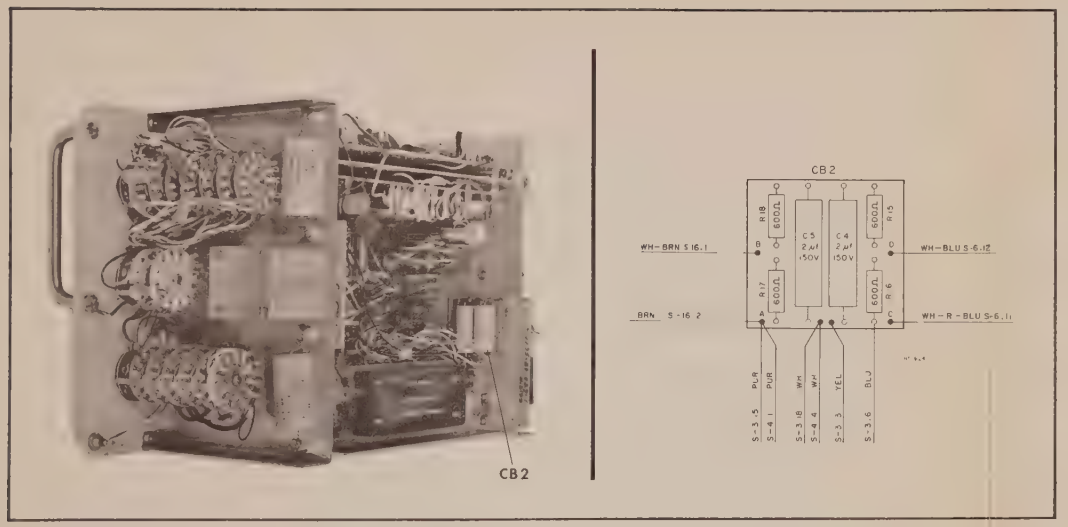
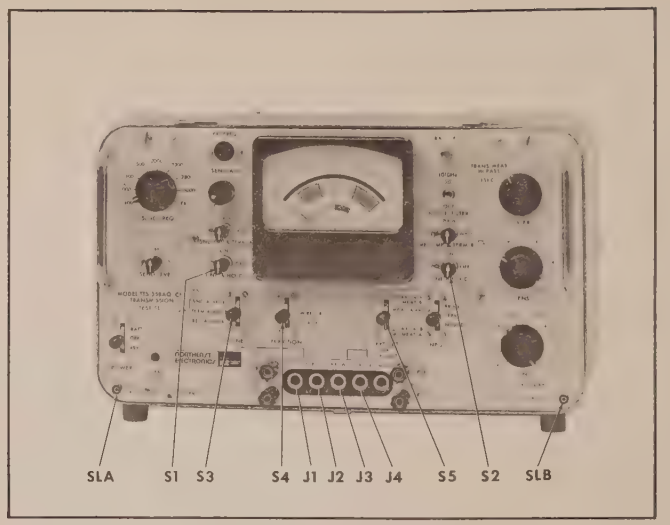
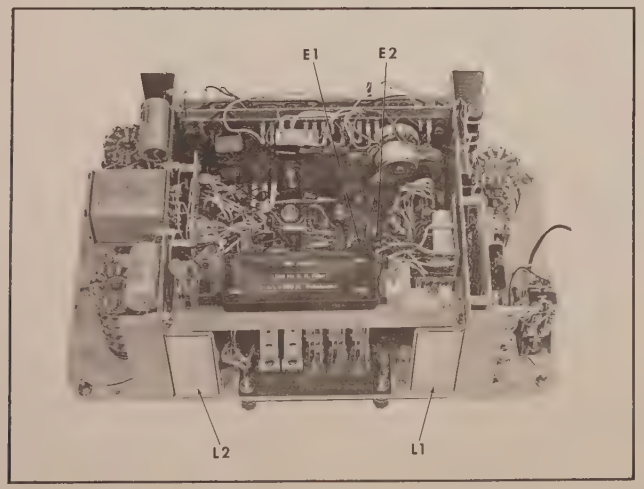


Figure 7—4. Input Switching Simplified Schematic Diagram







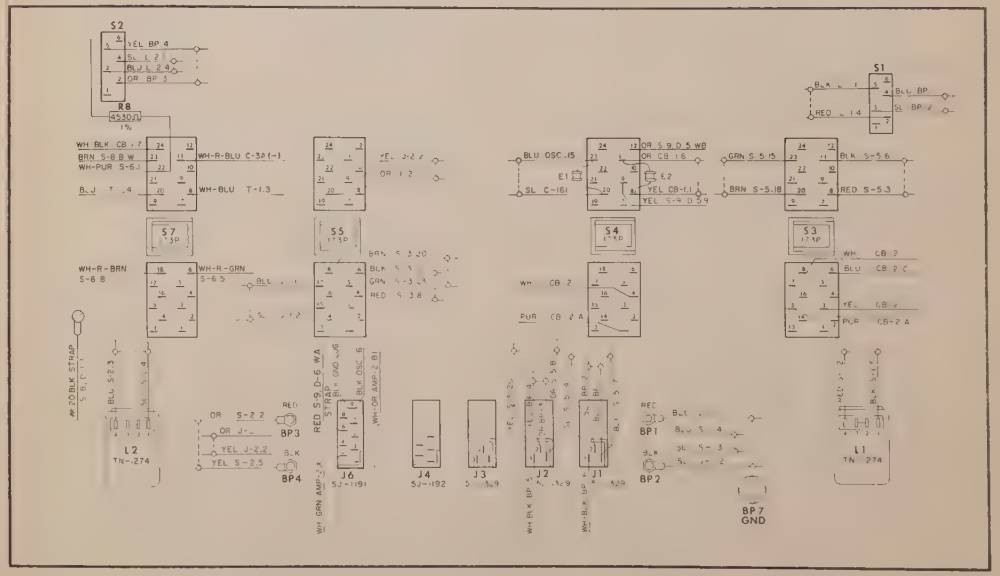
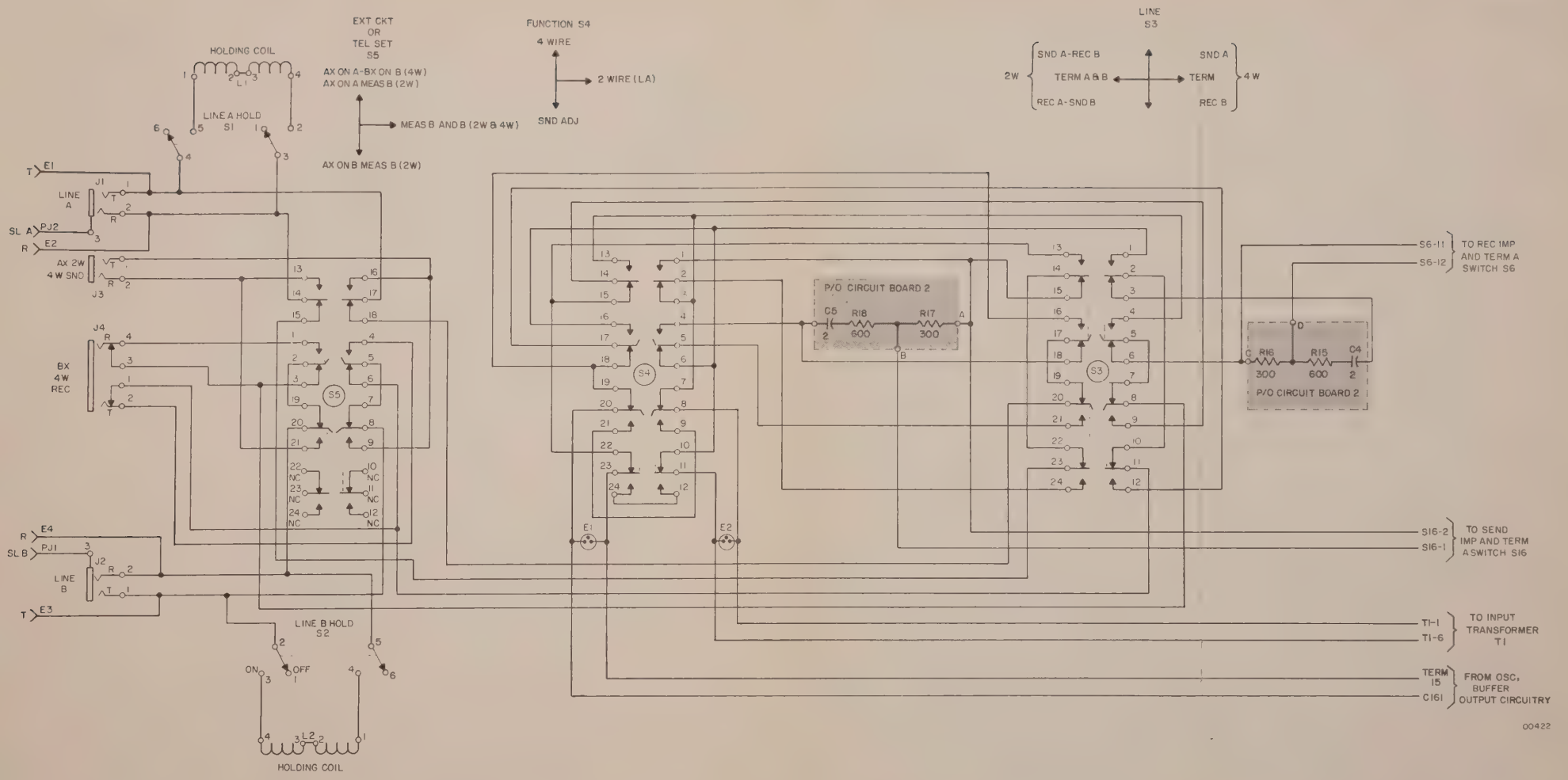
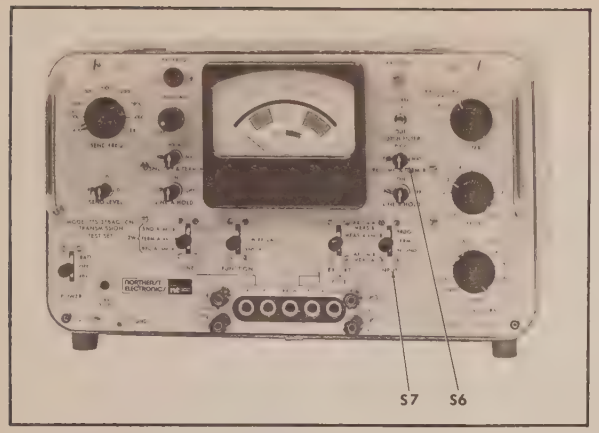


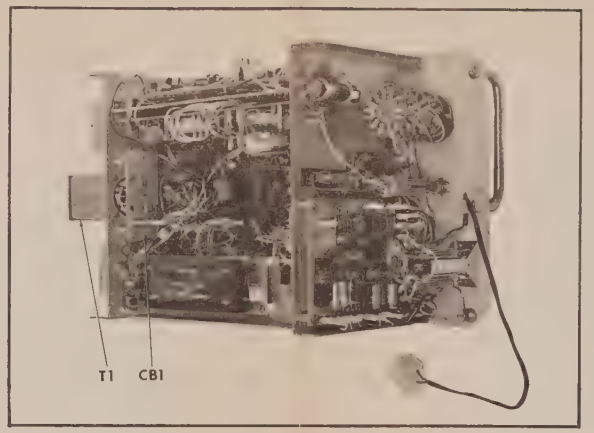
Figure 7—5. Send/Receive Switching Parts Location Diagram

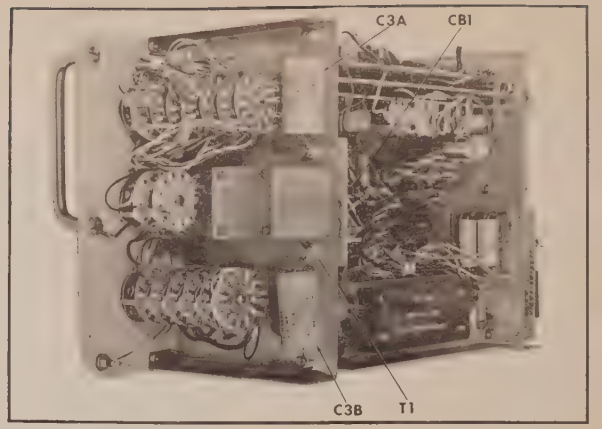


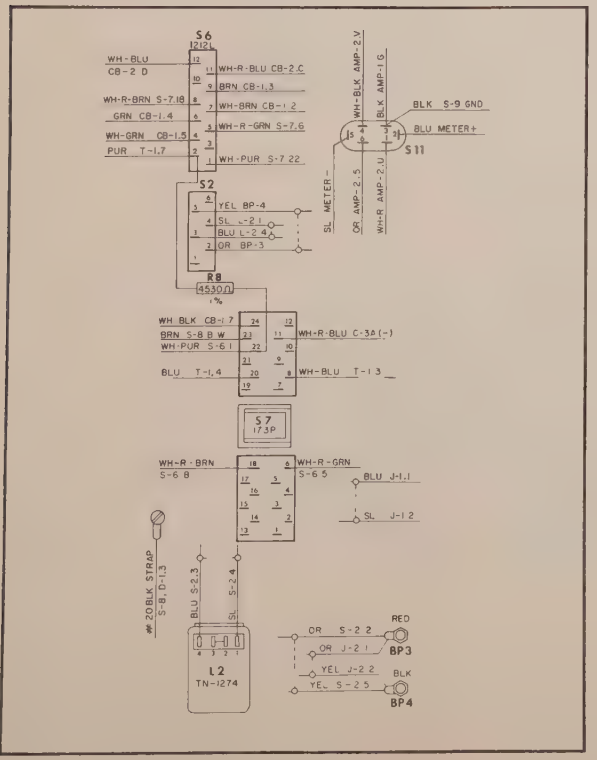
NOTES:
1. UNLESS OTHERWISE INDICATED:
   RESISTOR VALUES ARE IN OHMS
   CAPACITOR VALUES ARE IN MICROFARADS.
   INDUCTANCE VALUES ARE IN MILLIHENRYS.
2. S3, S4 AND S5 ARE SHOWN IN THE CENTER POSITION.

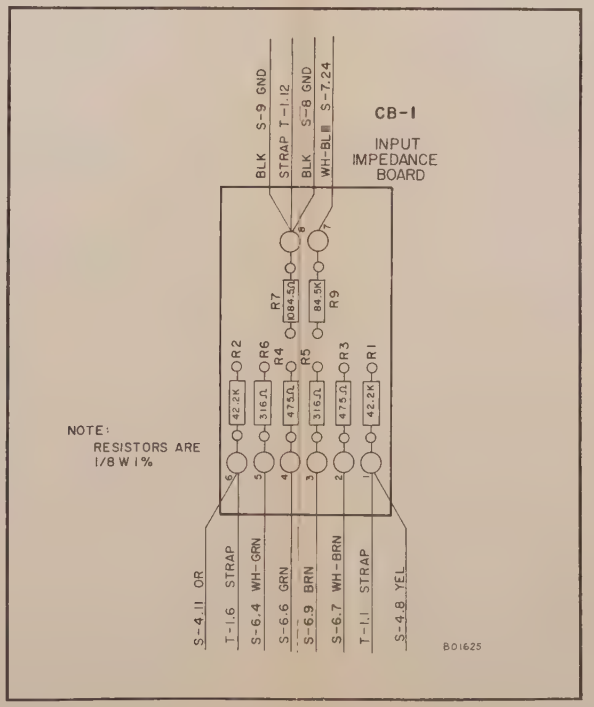
Figure 7—6. Send/Receive Switching Schematic Diagram











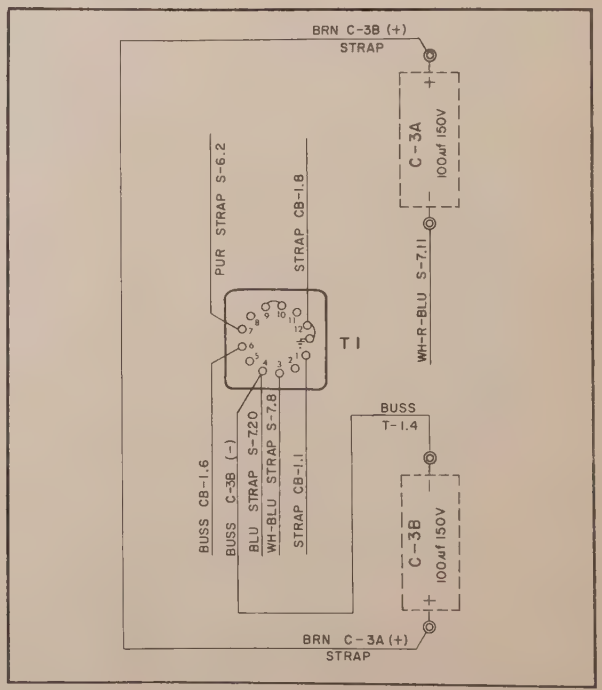


Figure 7—7. Input Circuit Parts Location Diagram

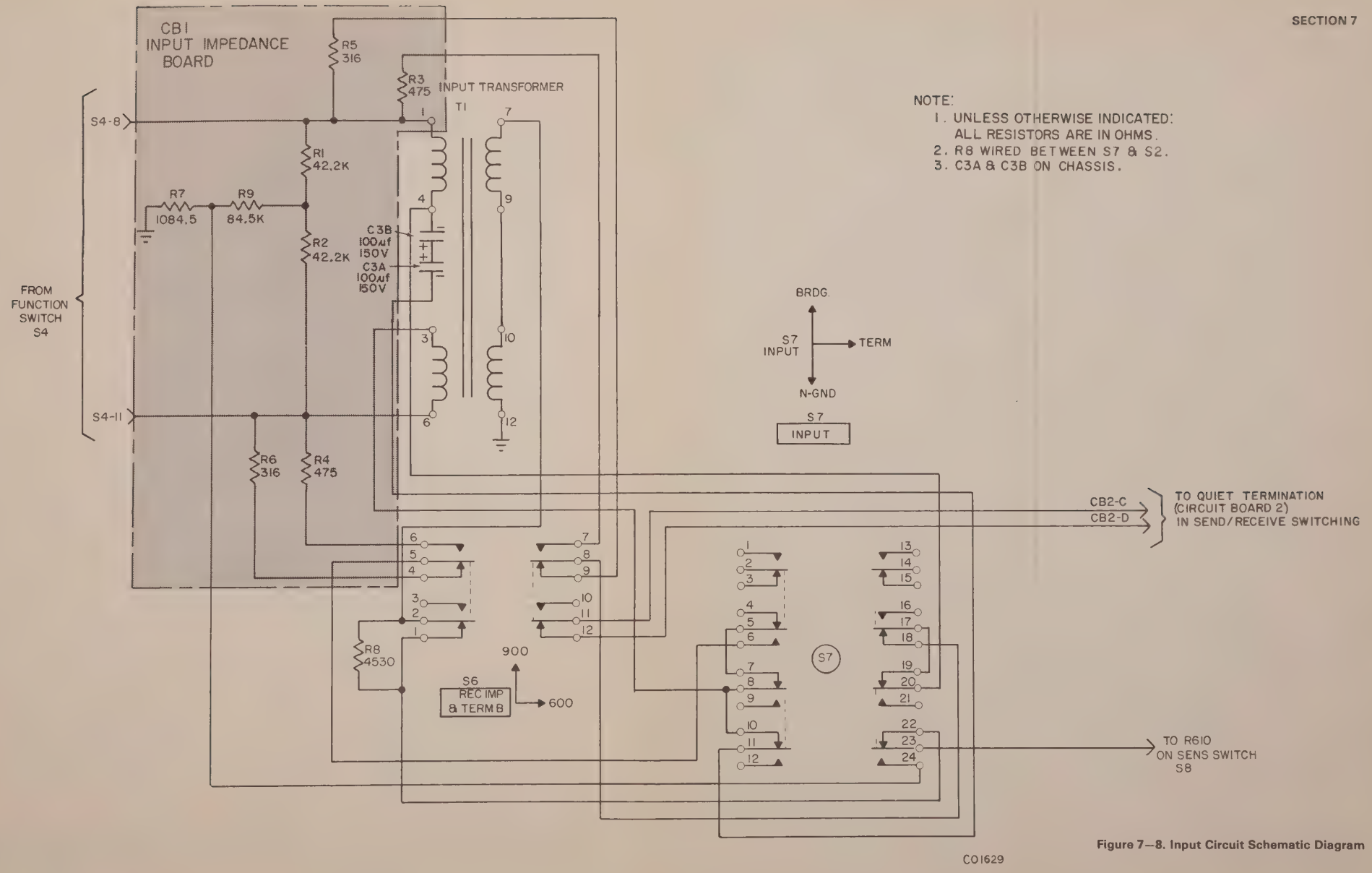
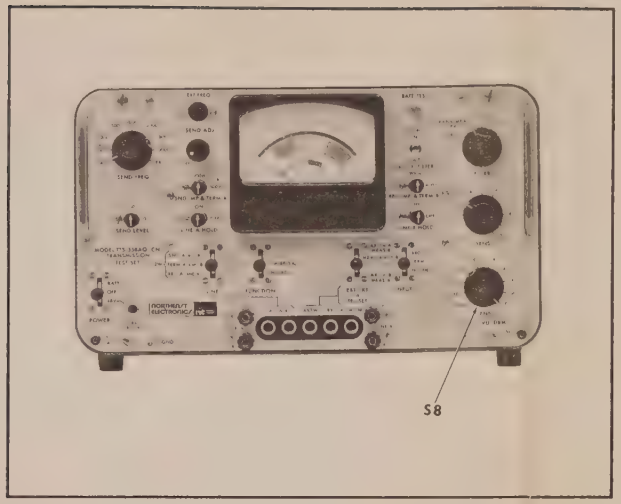
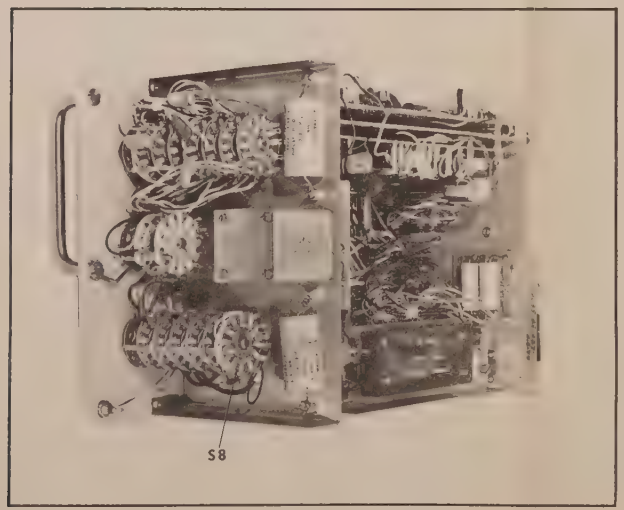


Figure 7—8. Input Circuit Schematic Diagram





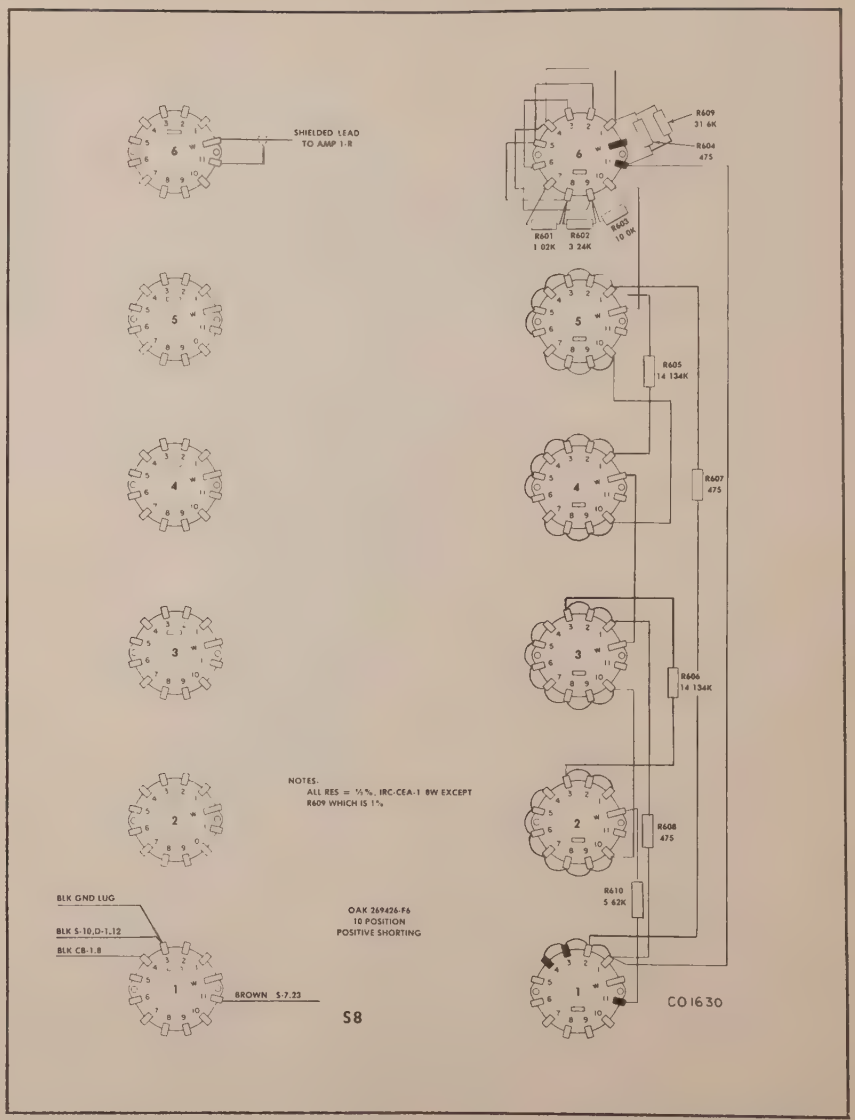


Figure 7—9. 10 dB SENS Switch S8 Parts Location Diagram

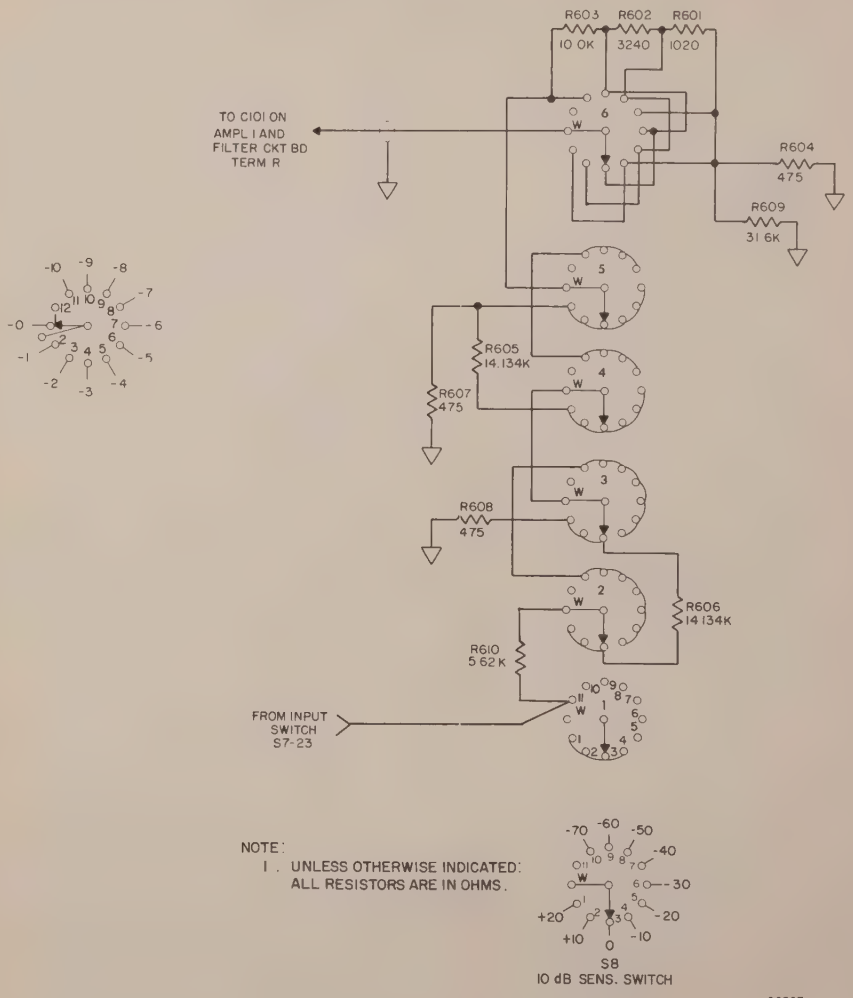
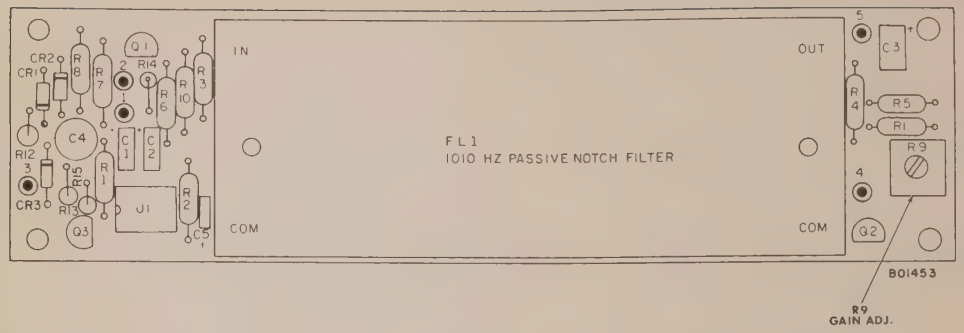
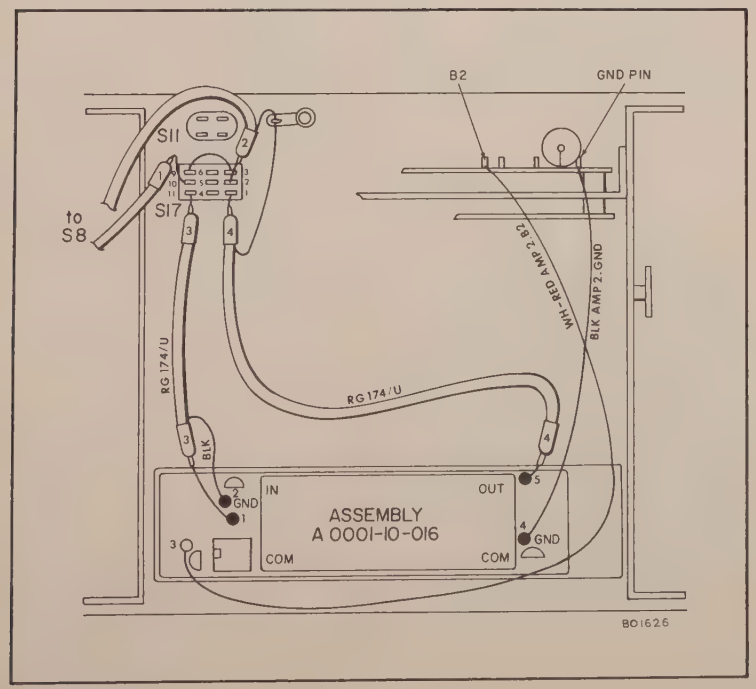


Figure 7—10. 10 dB SENS Switch S8 Schematic Diagram





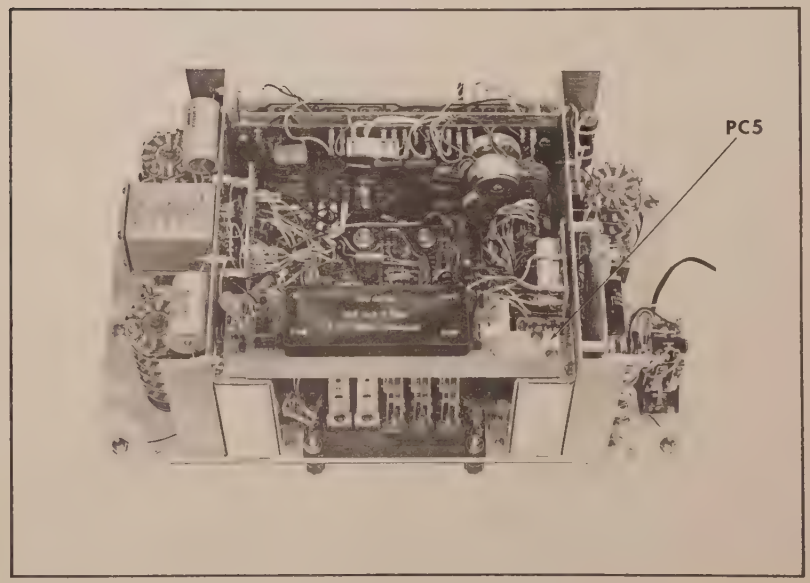
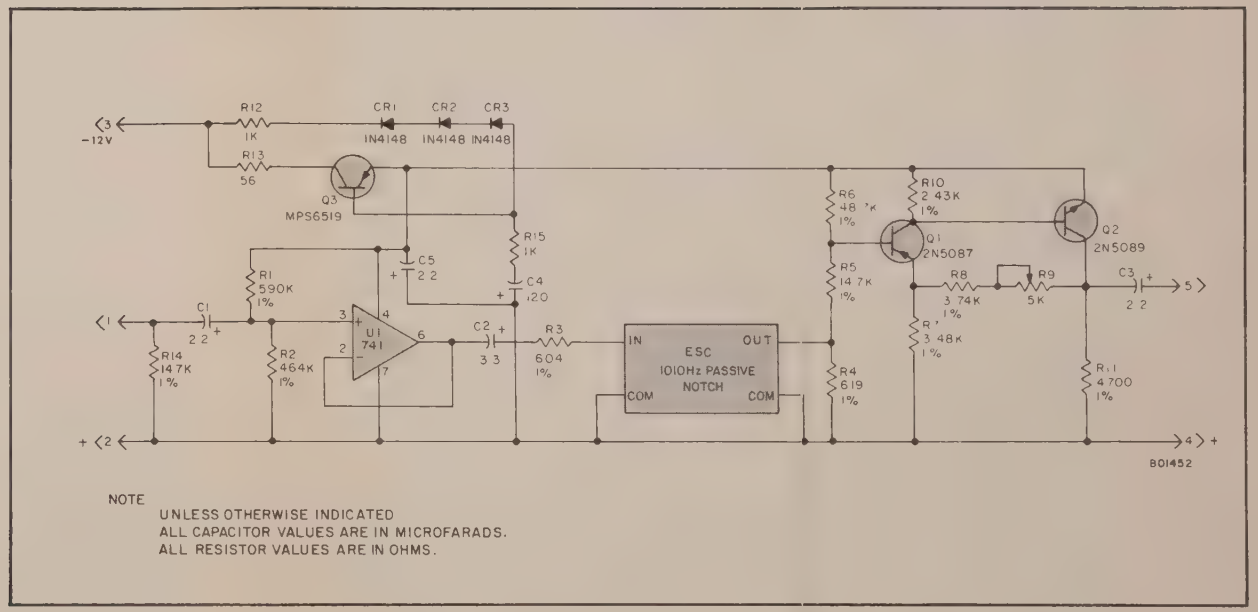
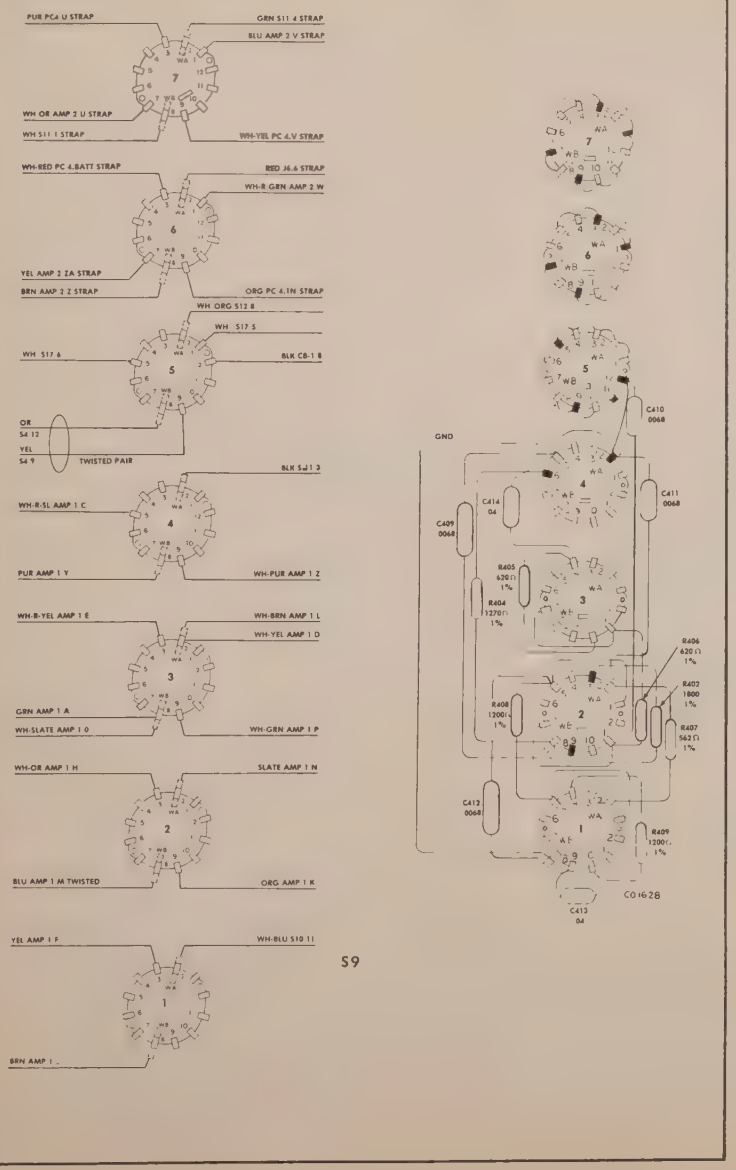


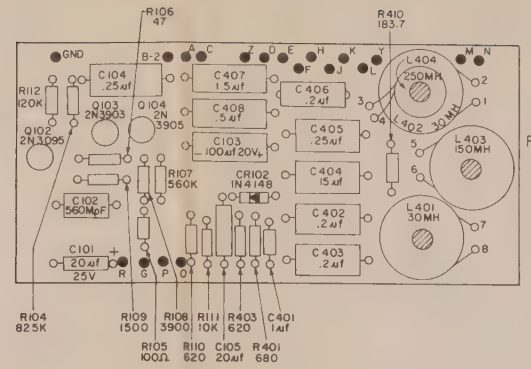
Figure 7—11. 1010 Hz Notch Filter (PC5) Parts Location Diagram

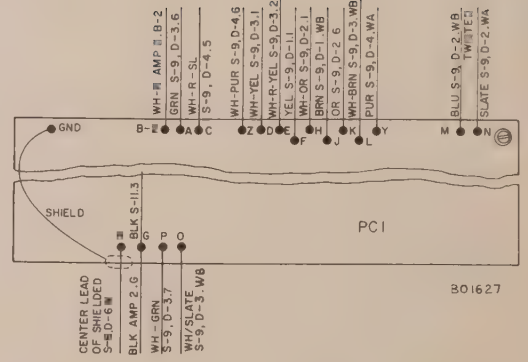


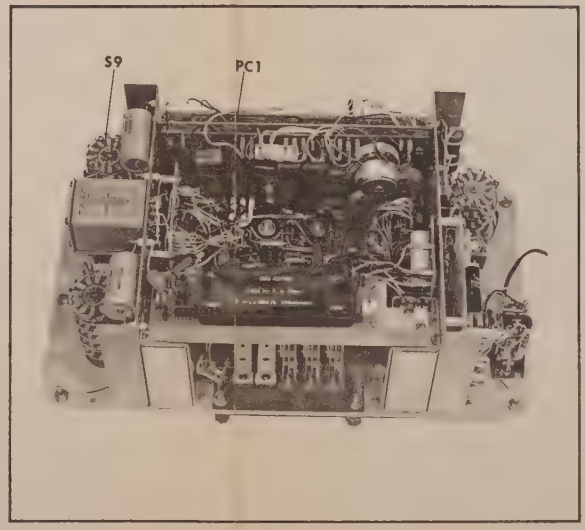
1010 HZ NOTCH FILTER	
NE PART NO	0001-10-016
REF DESIG	PC5
PC NO	96623

Figure 7—12. 1010 Hz Notch Filter (PC5) Schematic Diagram









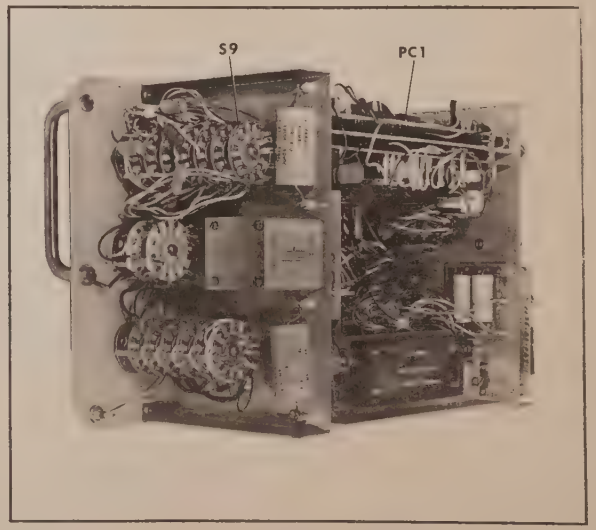
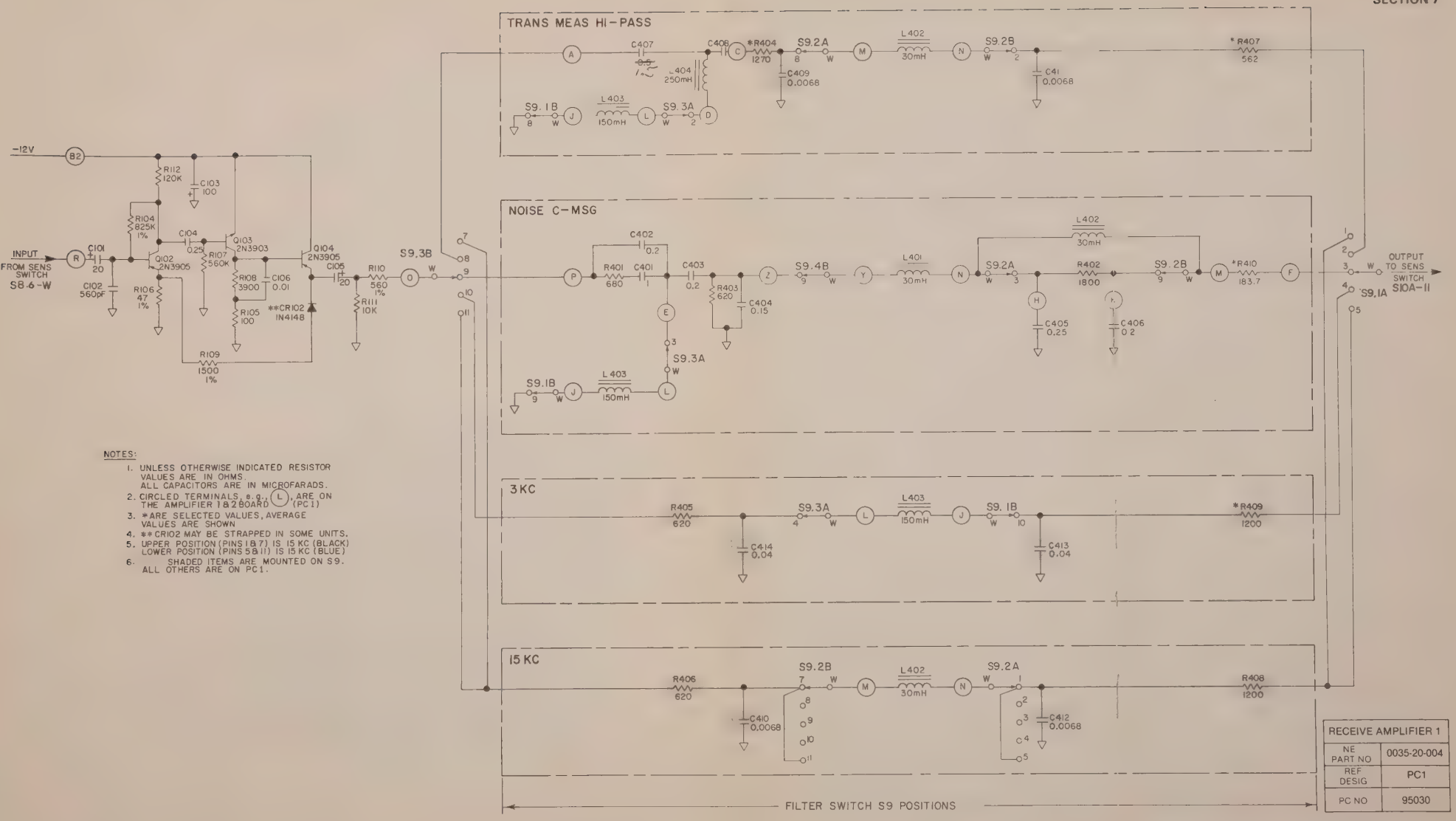


Figure 7—13. Receive Amplifier 1 (PC1) And FILTER Switch S9 Parts Location Diagram



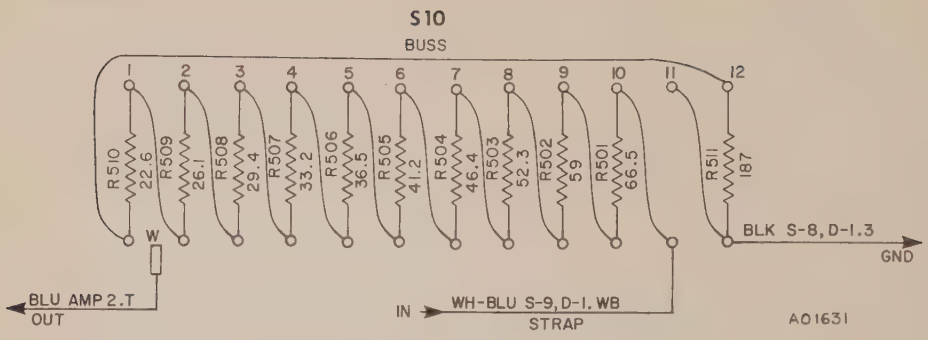
NOTES:

1. UNLESS OTHERWISE INDICATED RESISTOR VALUES ARE IN OHMS. ALL CAPACITORS ARE IN MICROFARADS.
2. CIRCLED TERMINALS, e.g., (L), ARE ON THE AMPLIFIER 1 & 2 BOARD (PC1)
3. * ARE SELECTED VALUES, AVERAGE VALUES ARE SHOWN
4. ** CR102 MAY BE STRAPPED IN SOME UNITS.
5. UPPER POSITION (PINS 1 & 7) IS 15 KC (BLACK) LOWER POSITION (PINS 5 & 11) IS 15 KC (BLUE)
6. SHADED ITEMS ARE MOUNTED ON S9. ALL OTHERS ARE ON PC1.

RECEIVE AMPLIFIER 1	
NE PART NO	0035-20-004
REF DESIG	PC1
PC NO	95030

DG 1638

Figure 7—14. Receive Amplifier 1 (PC1) And FILTER Switch S9 Schematic Diagram



OAK 269428-J2C
(PA-024-6277) PA-2004
2 DECK-11 POS
POSITIVE SHORTING

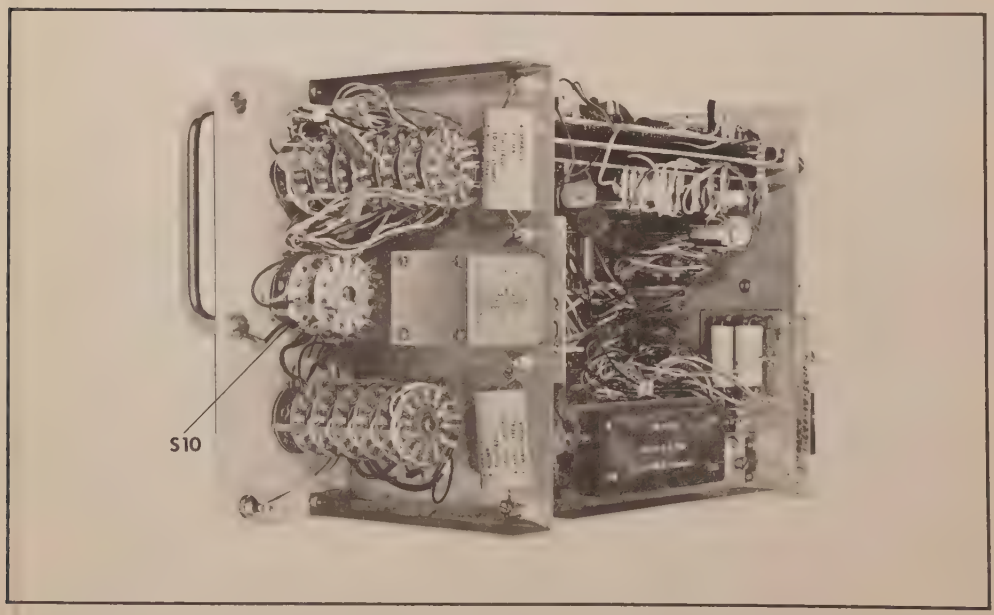


Figure 7—15. 1 dB SENS Switch S10 Parts Location Diagram

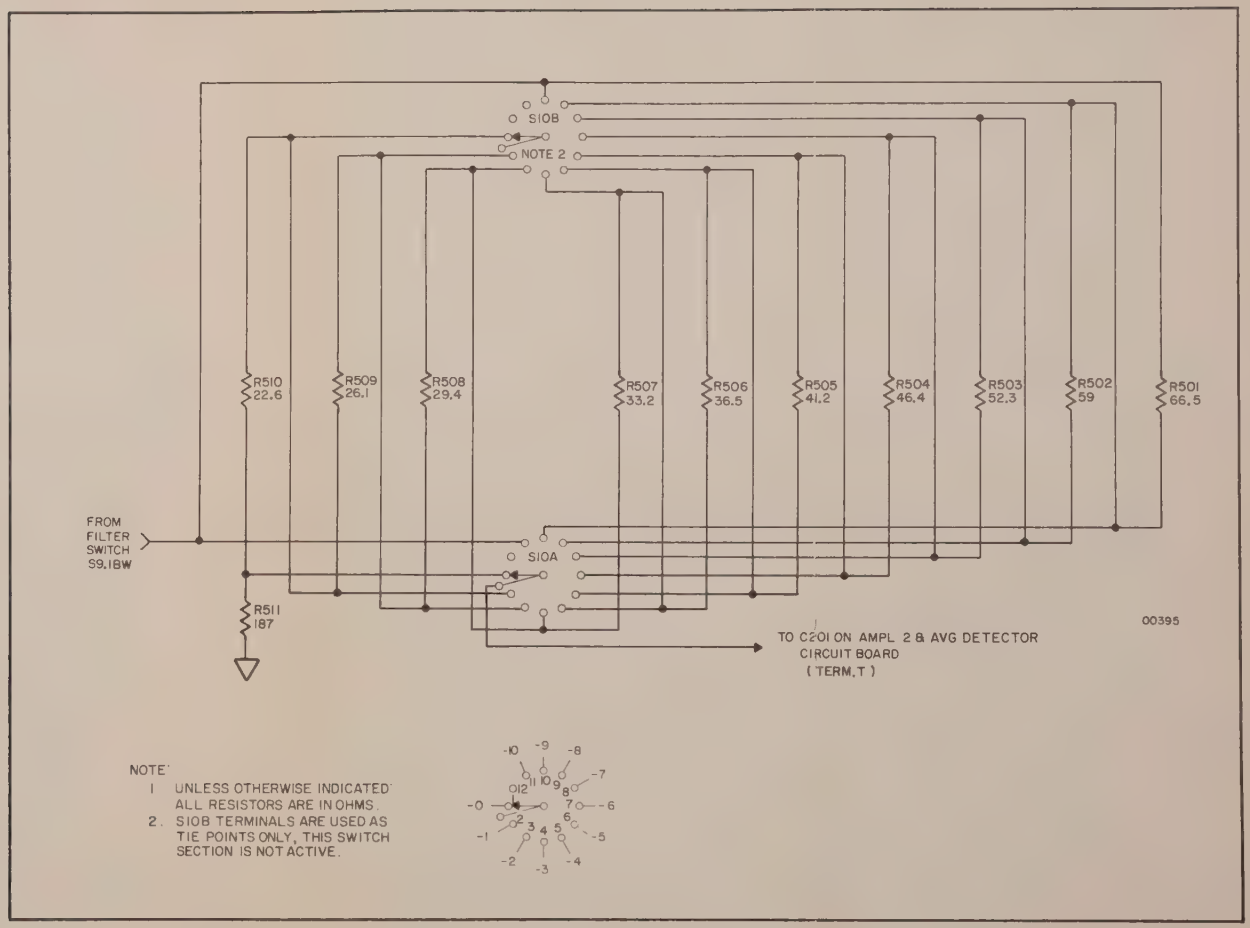
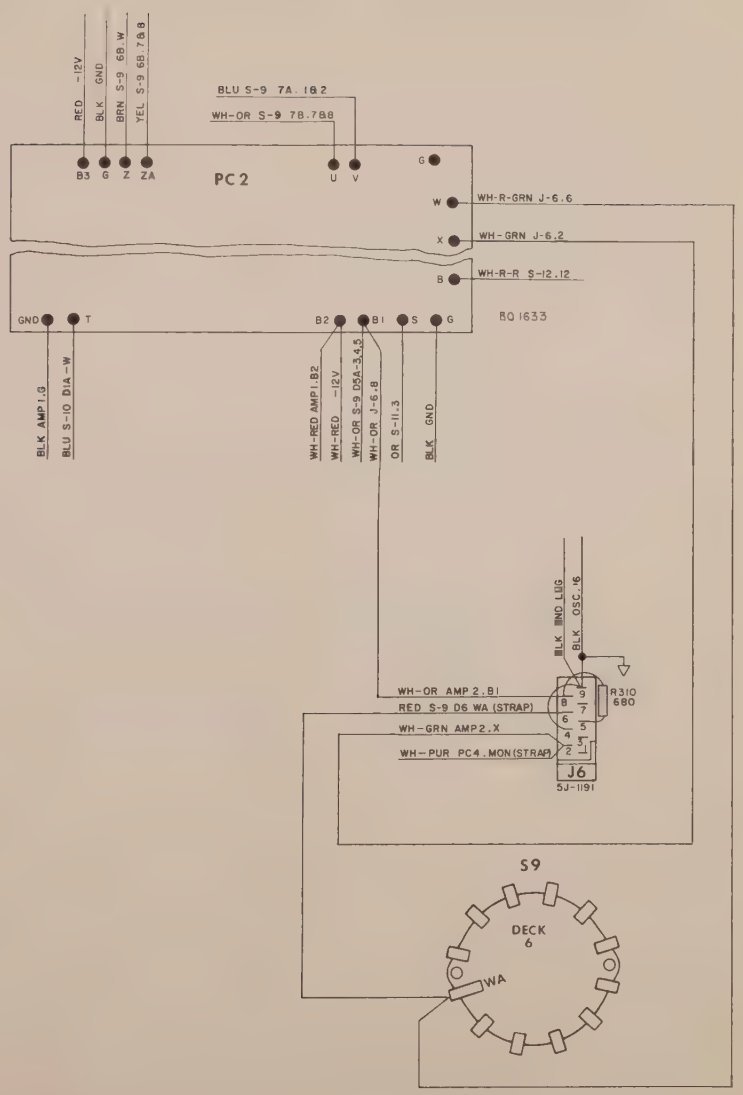
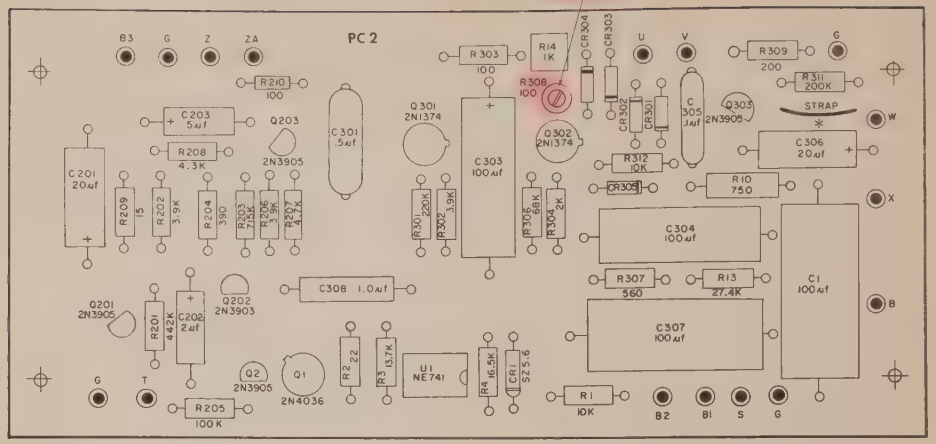


Figure 7—16. 1 dB SENS Switch S10 Schematic Diagram





NOTES:
1. *R310 ON OLD UNITS.
2. ALL DIODES ARE IN198 UNLESS OTHERWISE SPECIFIED.

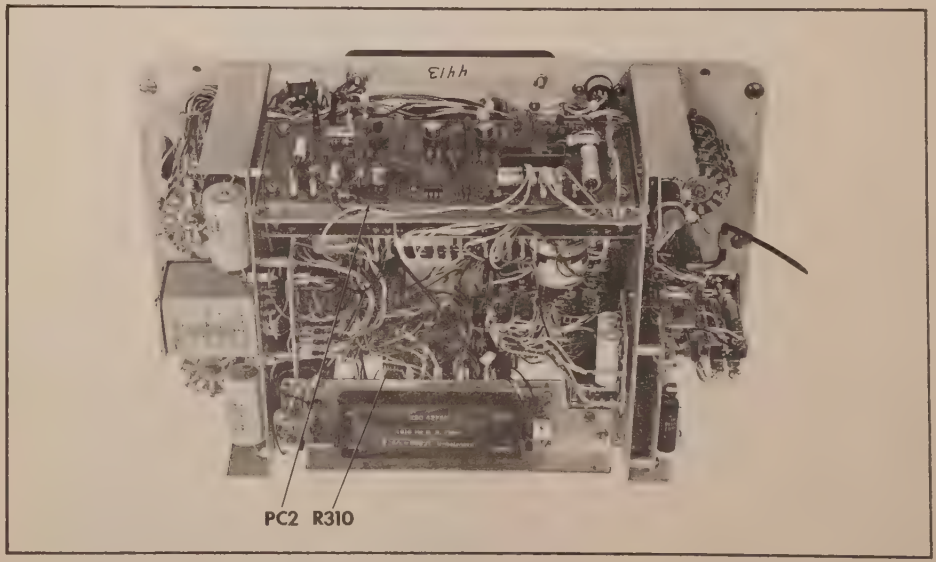
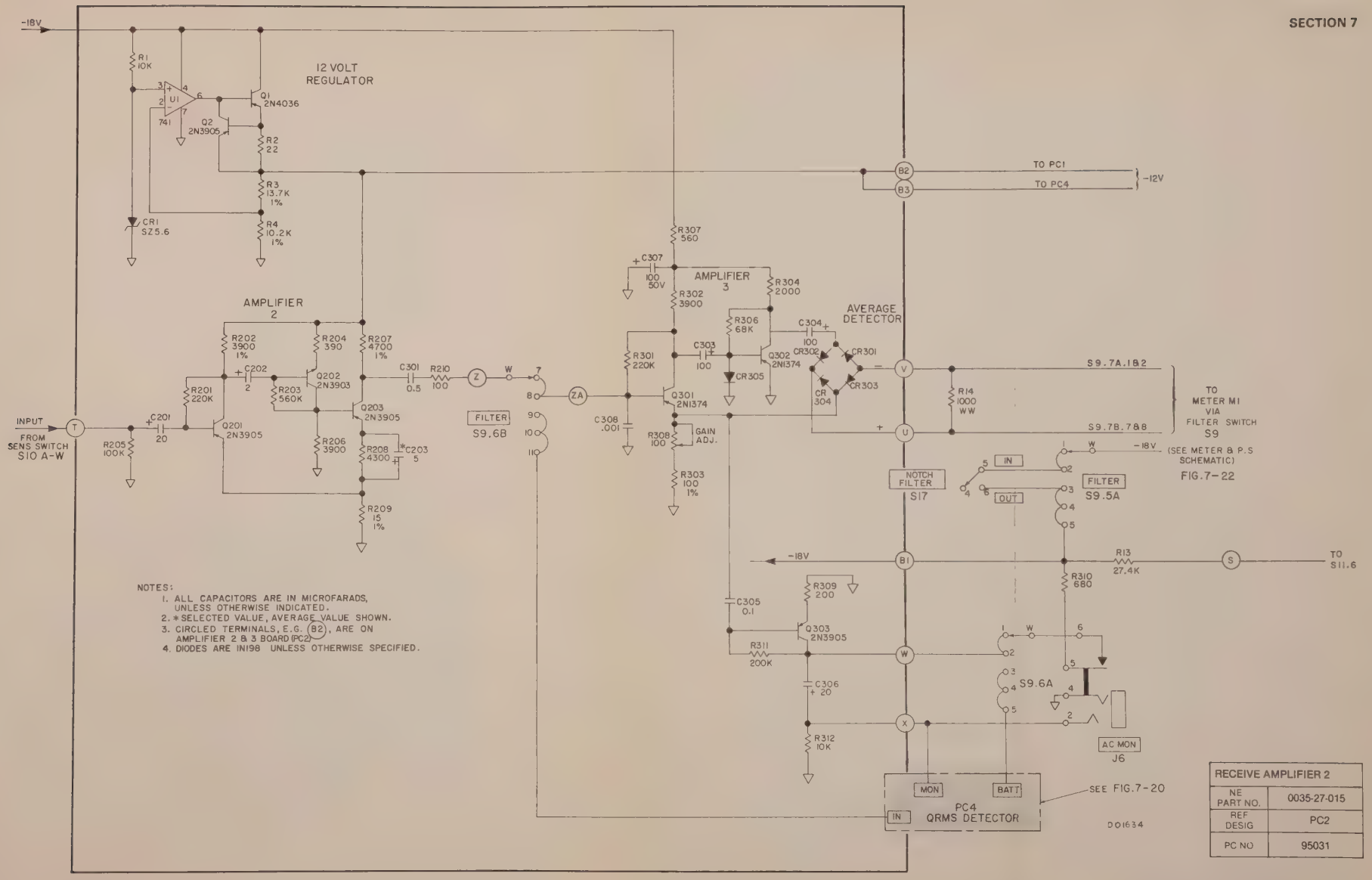


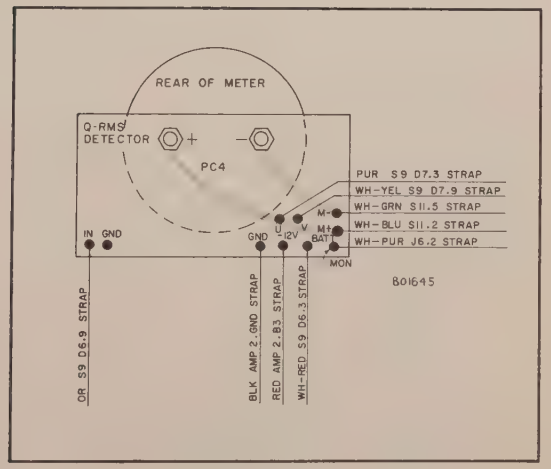
Figure 7—17. Receive Amplifier 2 (PC2) Parts Location Diagram

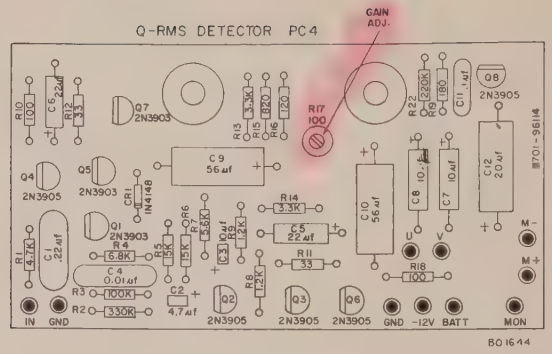


NOTES:
1. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE INDICATED.
2. *SELECTED VALUE, AVERAGE VALUE SHOWN.
3. CIRCLED TERMINALS, E.G. (B2), ARE ON AMPLIFIER 2 & 3 BOARD (PC2)
4. DIODES ARE IN198 UNLESS OTHERWISE SPECIFIED.

RECEIVE AMPLIFIER 2	
NE PART NO.	0035-27-015
REF DESIG	PC2
PC NO	95031

Figure 7—18. Receive Amplifier 2 (PC2) Schematic Diagram





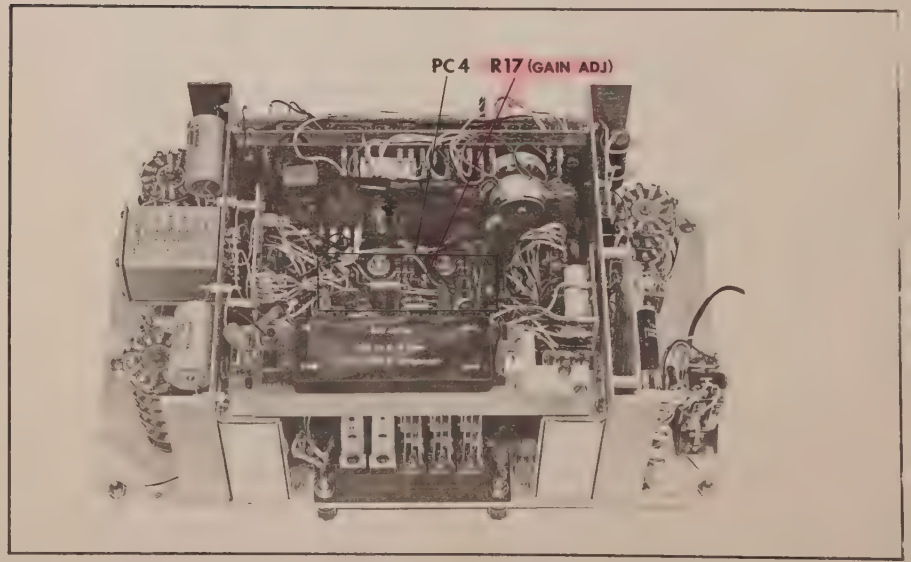
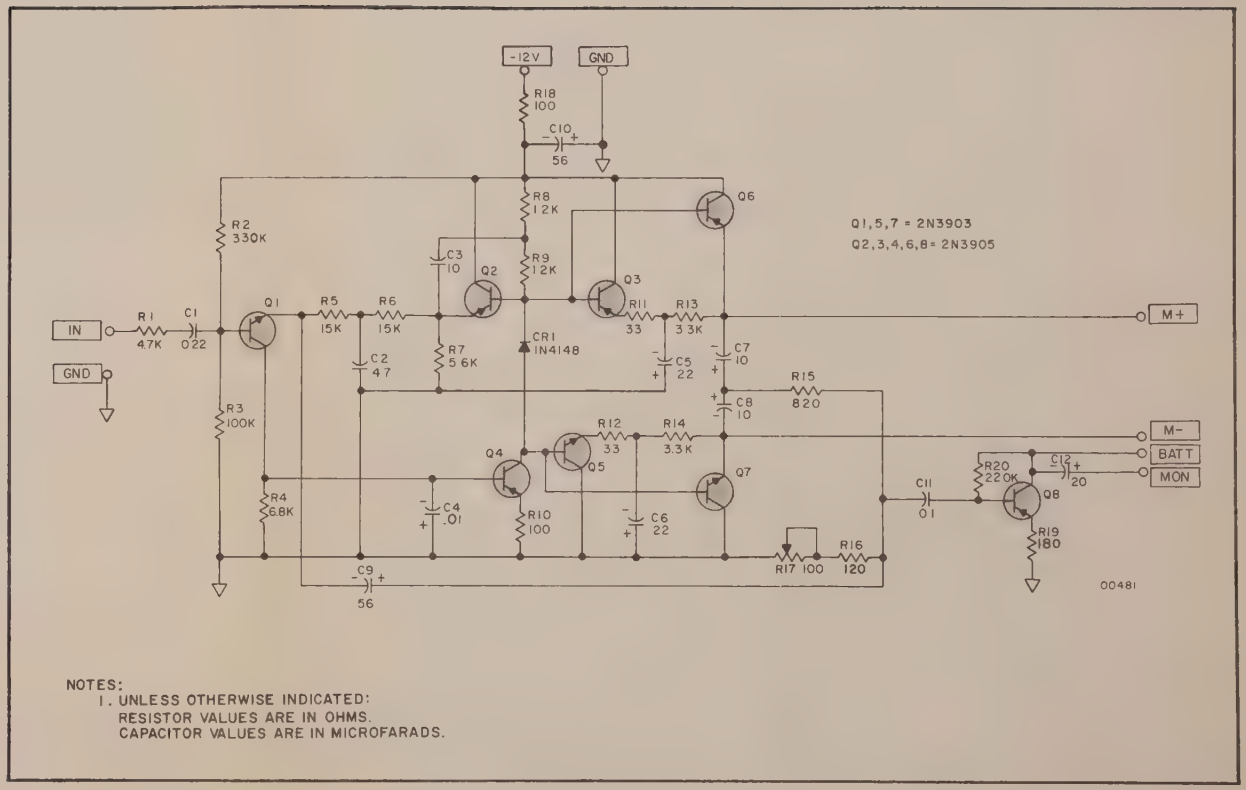


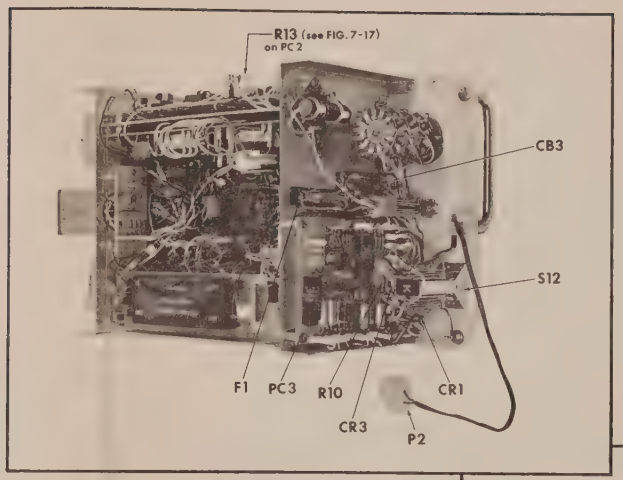
Figure 7—19. QRMS Detector (PC4) Parts Location Diagram

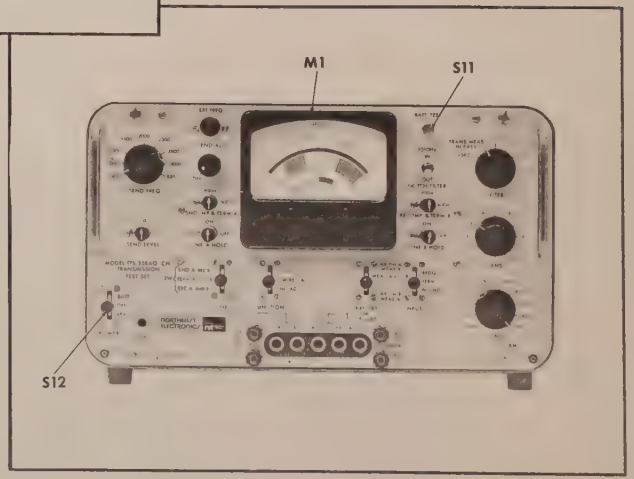


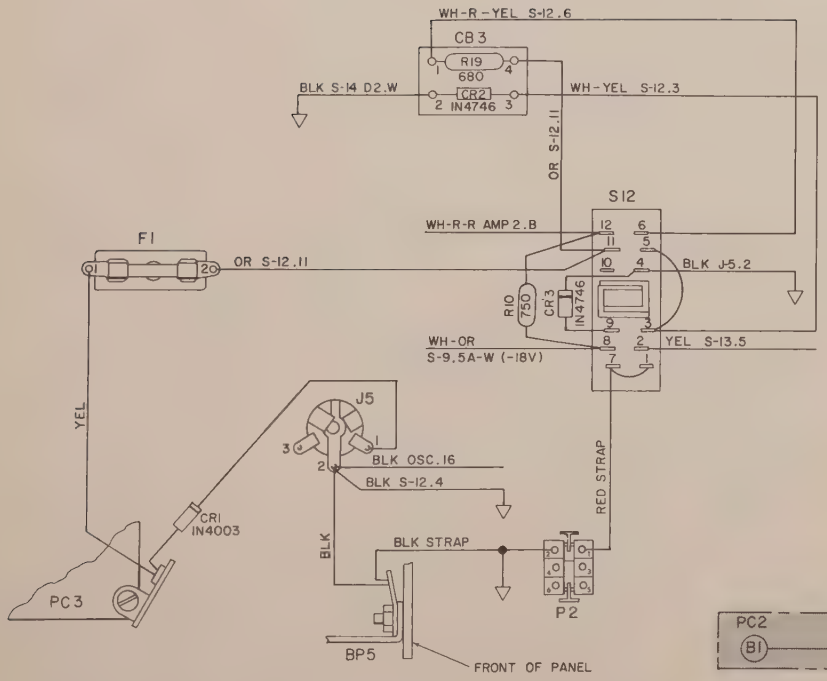
NOTES:
1. UNLESS OTHERWISE INDICATED:
   RESISTOR VALUES ARE IN OHMS.
   CAPACITOR VALUES ARE IN MICROFARADS.

QRMS DETECTOR	
NE PART NO	0035-27-029
REF DESIG	PC4
PC NO	96114

Figure 7—20. QRMS Detector (PC4) Schematic Diagram







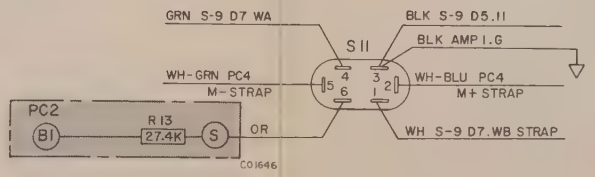


Figure 7—21. Meter M1 And Power Supply Parts Location Diagram

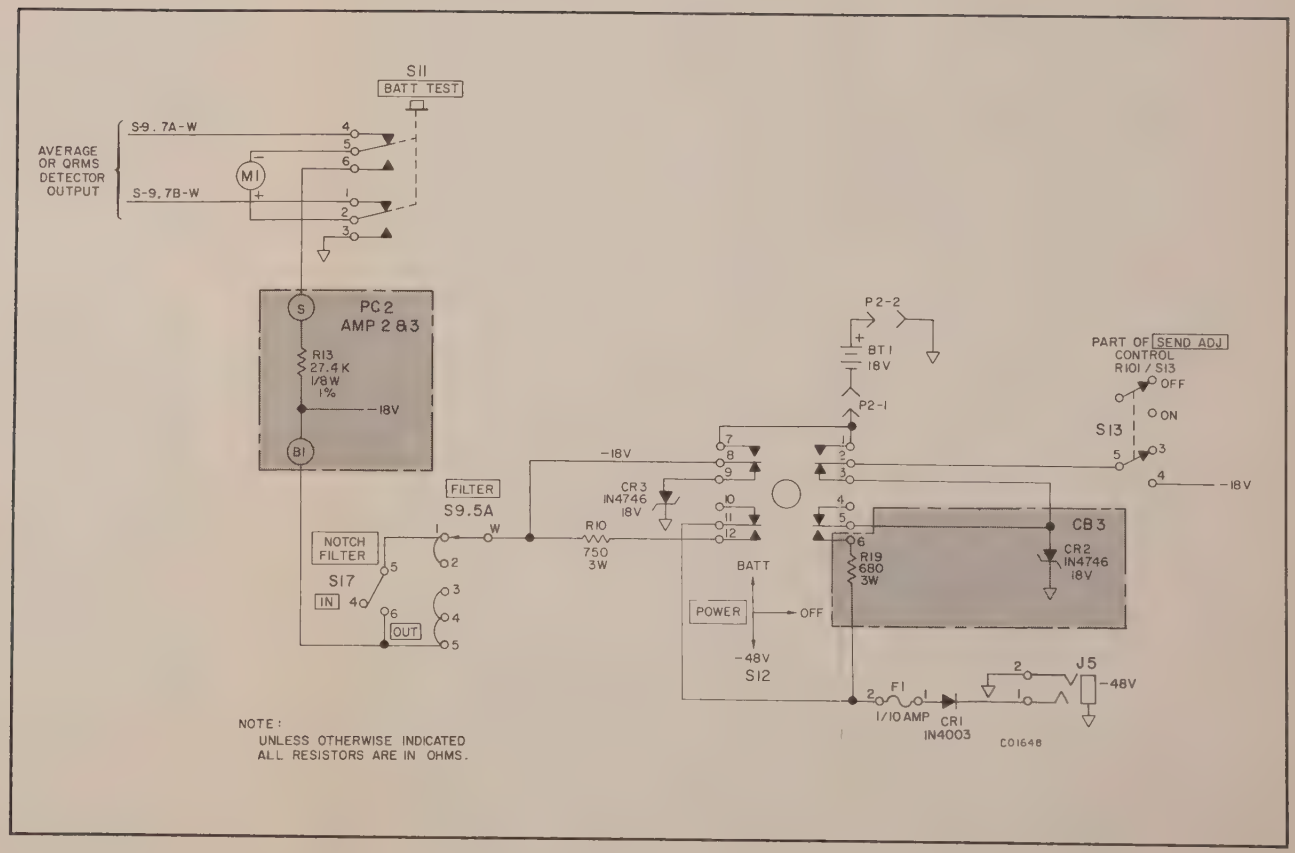
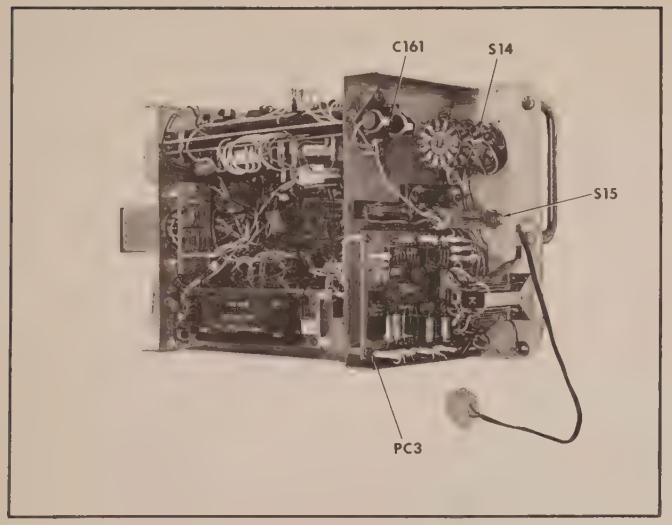
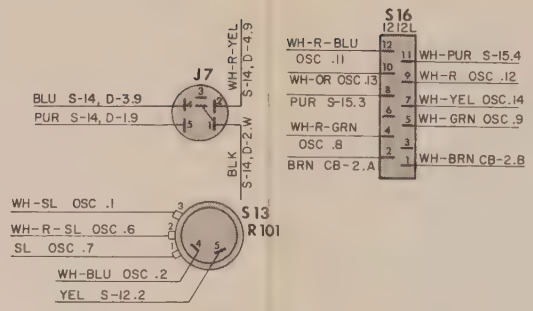
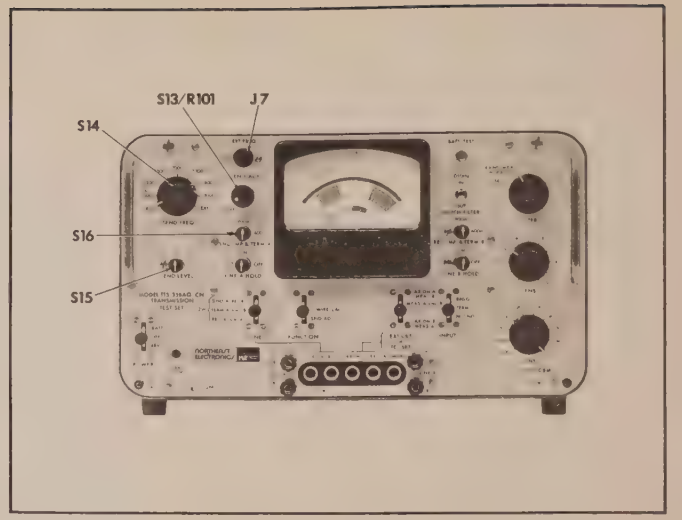
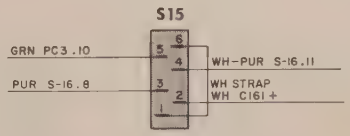


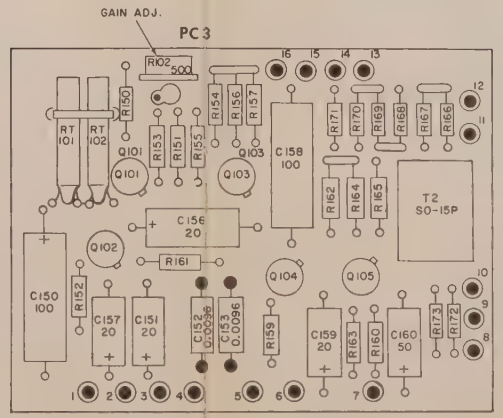
Figure 7—22. Meter M1 And Power Supply Schematic Diagram



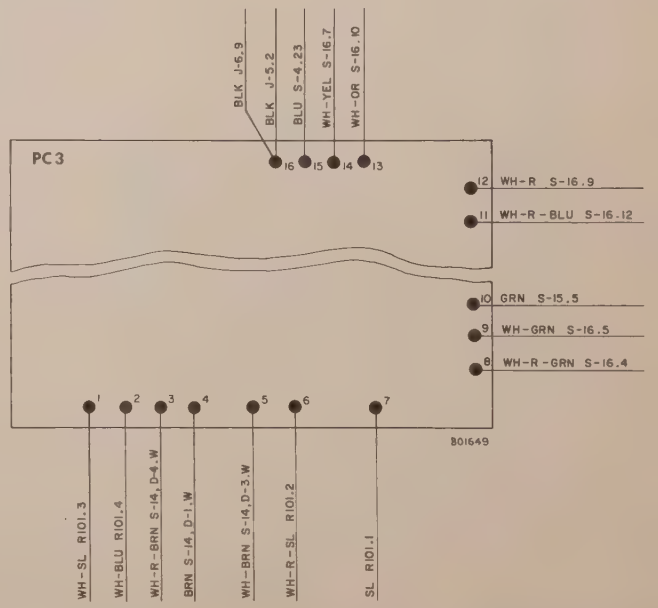








NOTES:
1. TRANSISTORS ARE 2N1375
2. FOR RESISTOR-VALUES SEE FIG. 7-24



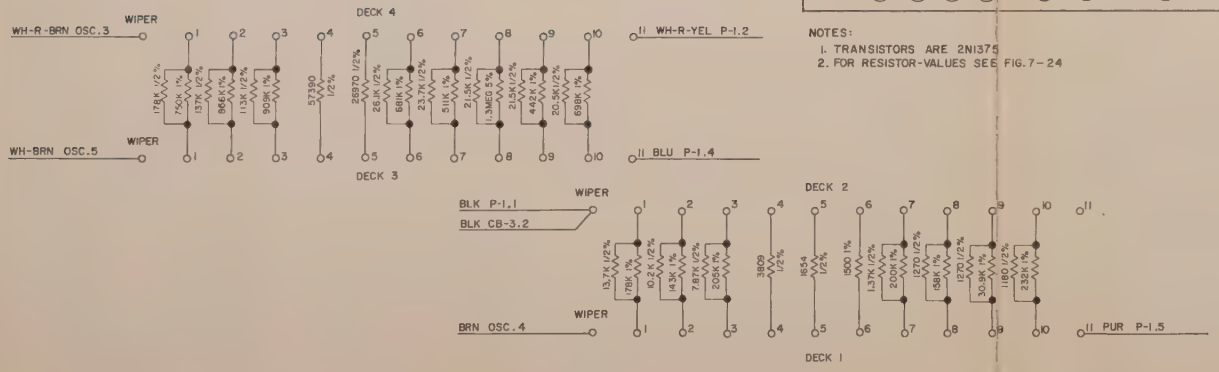
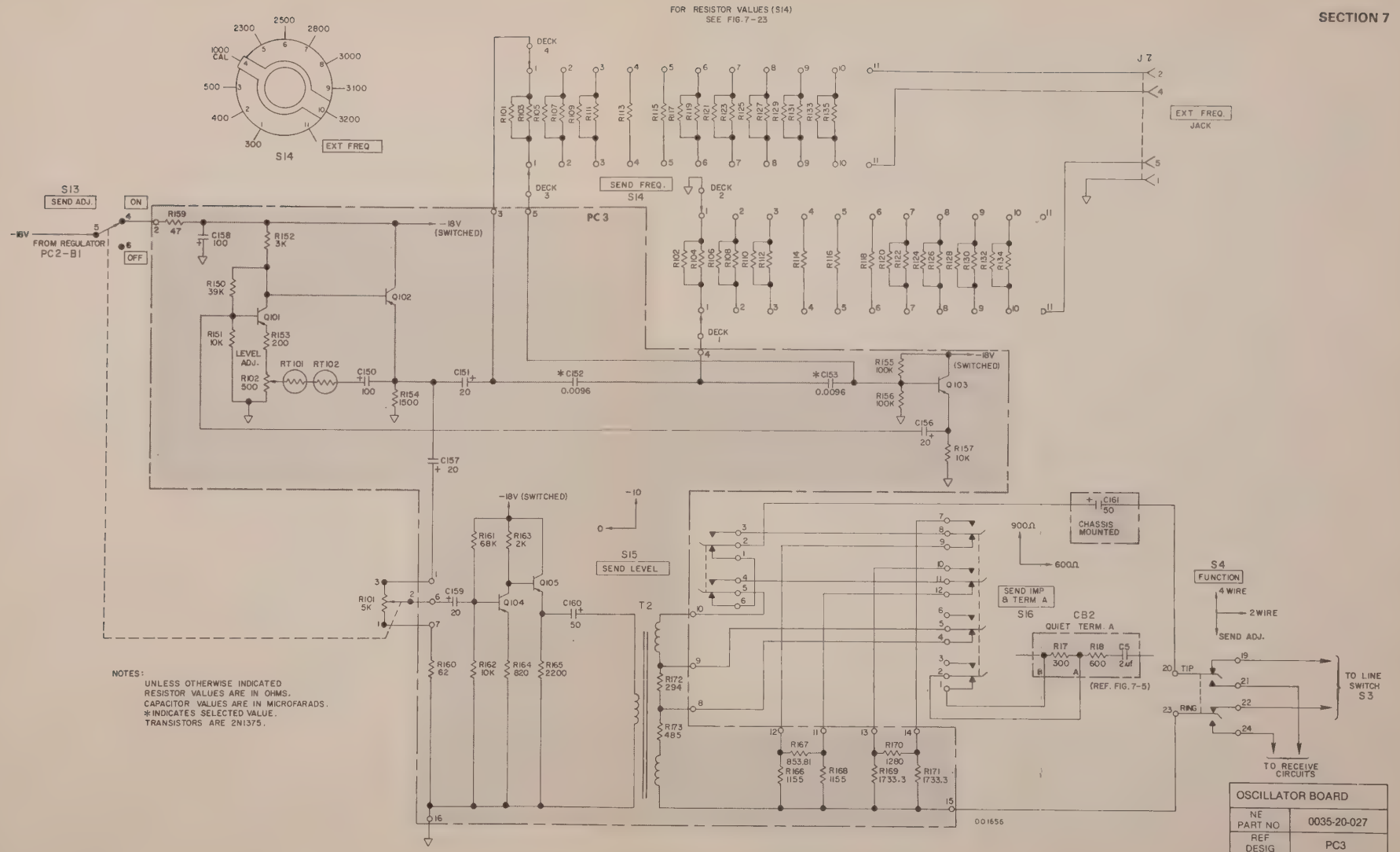


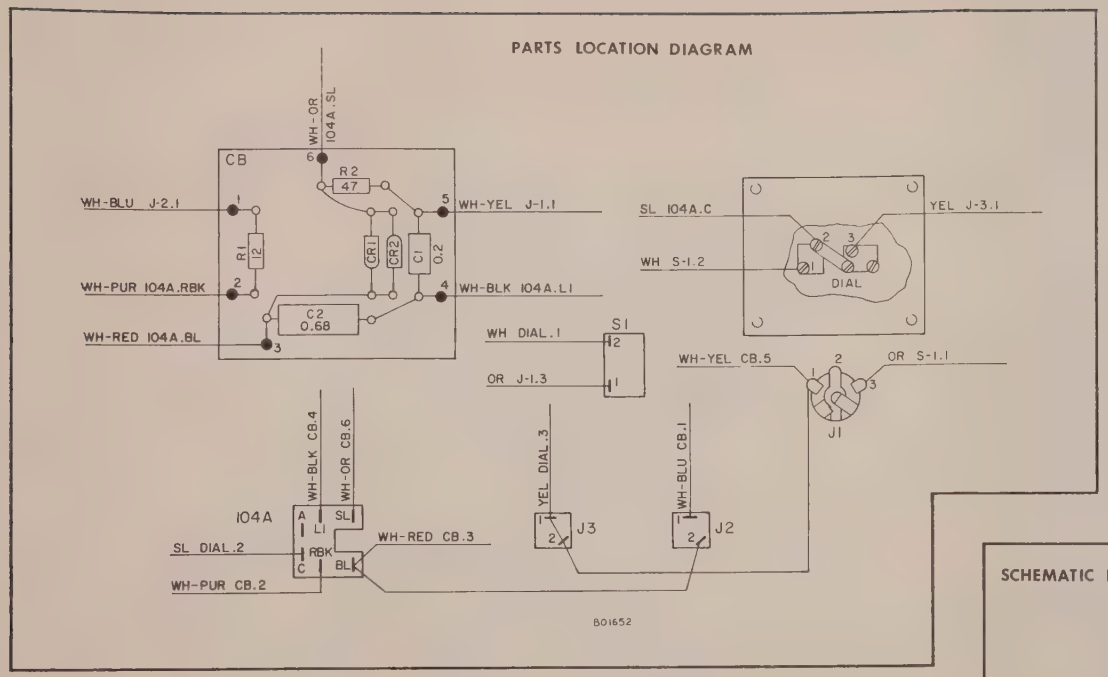
Figure 7—23. Oscillator Board (PC3) Parts Location Diagram



NOTES:
UNLESS OTHERWISE INDICATED
RESISTOR VALUES ARE IN OHMS.
CAPACITOR VALUES ARE IN MICROFARADS.
*INDICATES SELECTED VALUE.
TRANSISTORS ARE 2N1375.

OSCILLATOR BOARD	
NE PART NO	0035-20-027
REF DESIG	PC3
PC NO	95155

Figure 7—24. Oscillator Board (PC3) Schematic Diagram



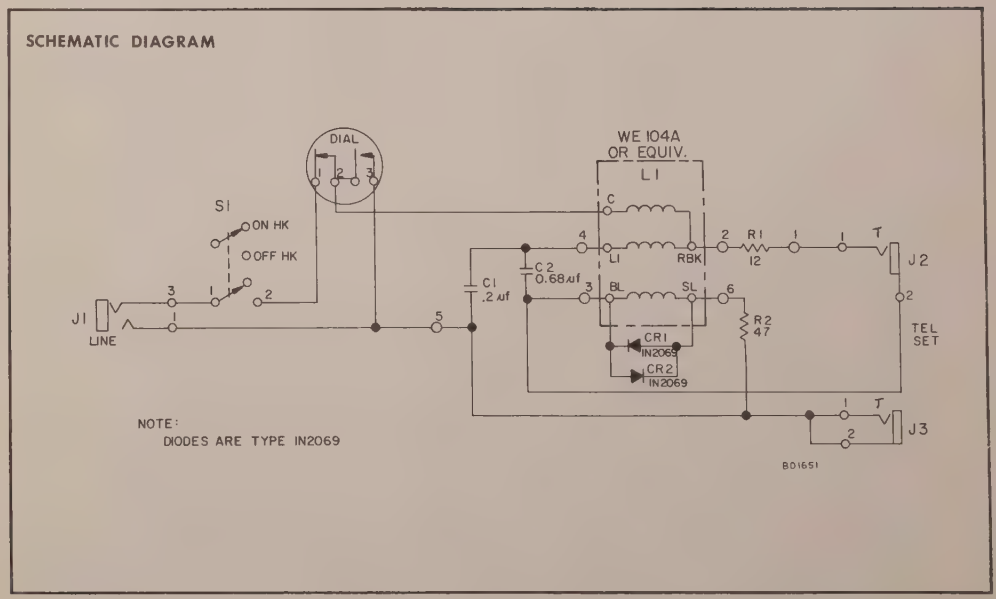


Figure 7—25. TTS-35XDT Dial And Talk Adapter Parts Location And Schematic Diagrams

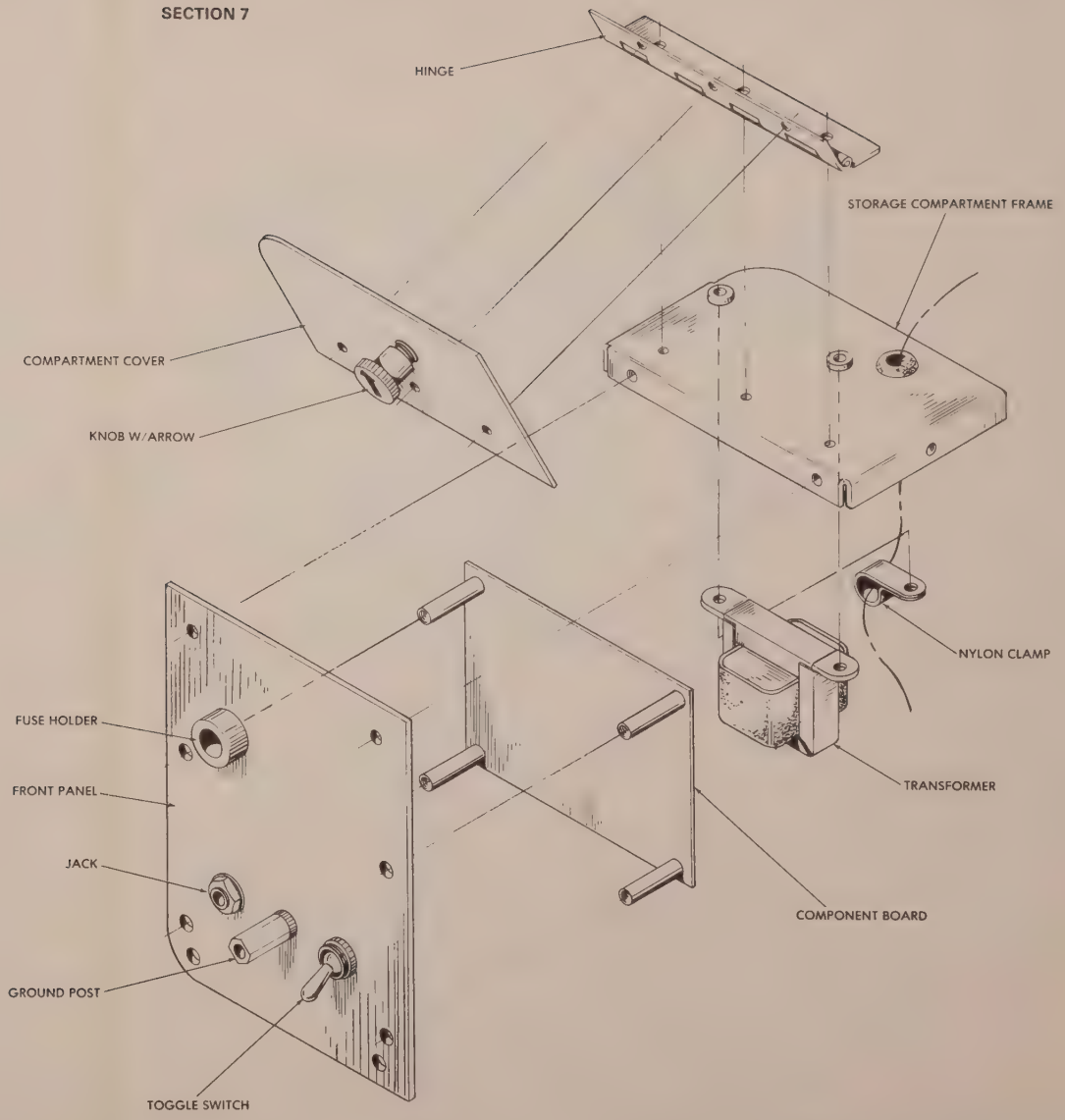
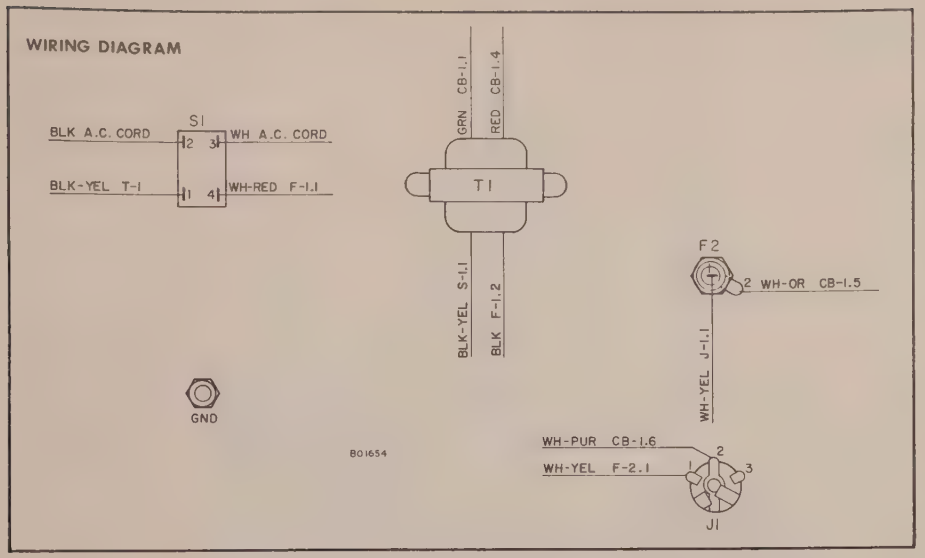
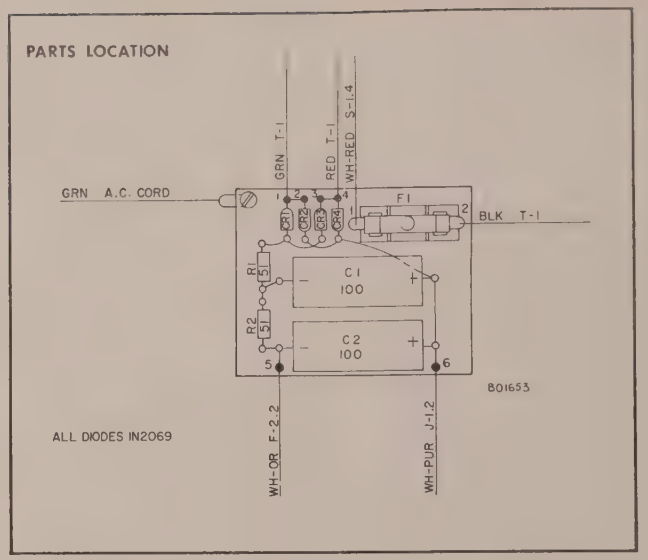


Figure 7—26. TTS-35XPS AC Power Supply Adapter Exploded View





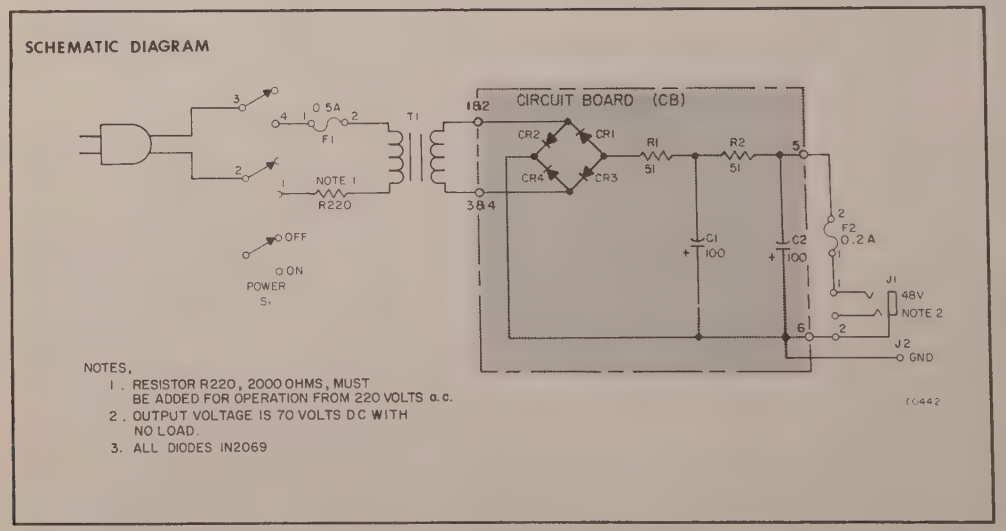


Figure 7—27. TTS-35XPS AC Power Supply Adapter Parts Location And Schematic Diagrams

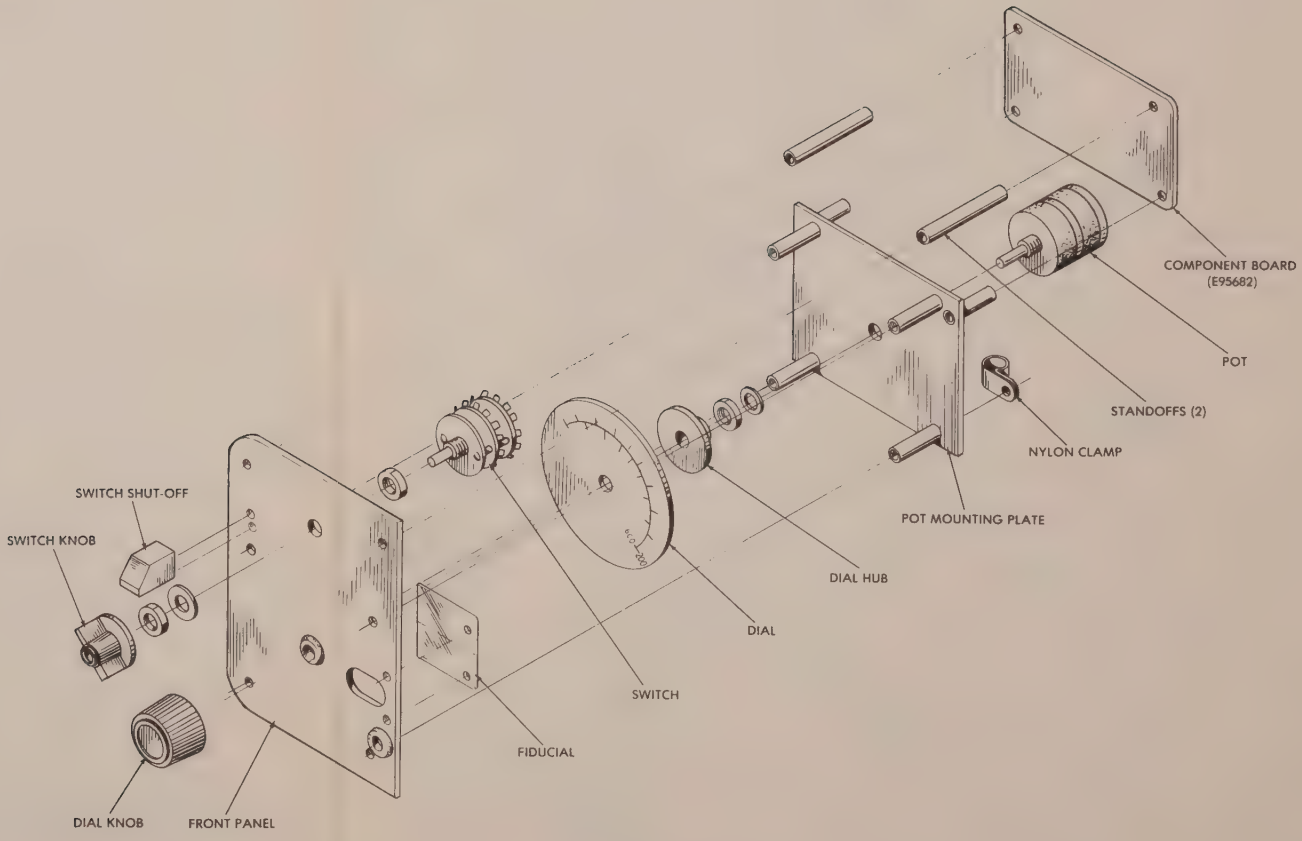
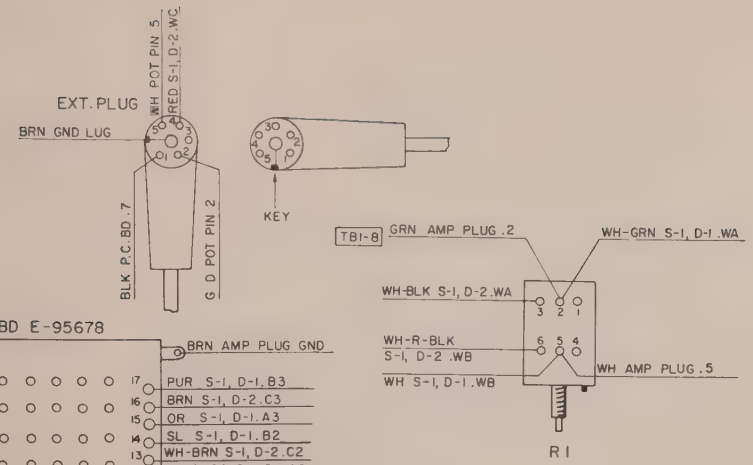
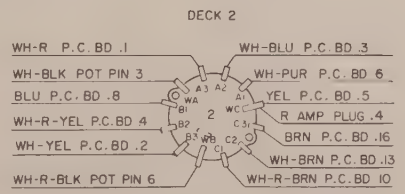
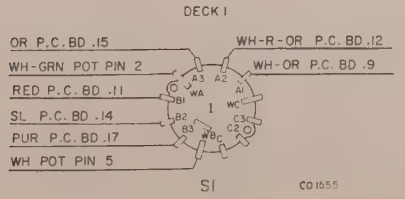
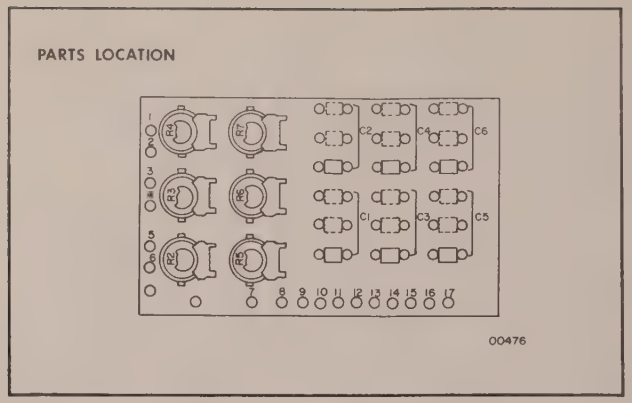


Figure 7—28. TTS-35XV Continuously Variable Frequency Adapter Exploded View









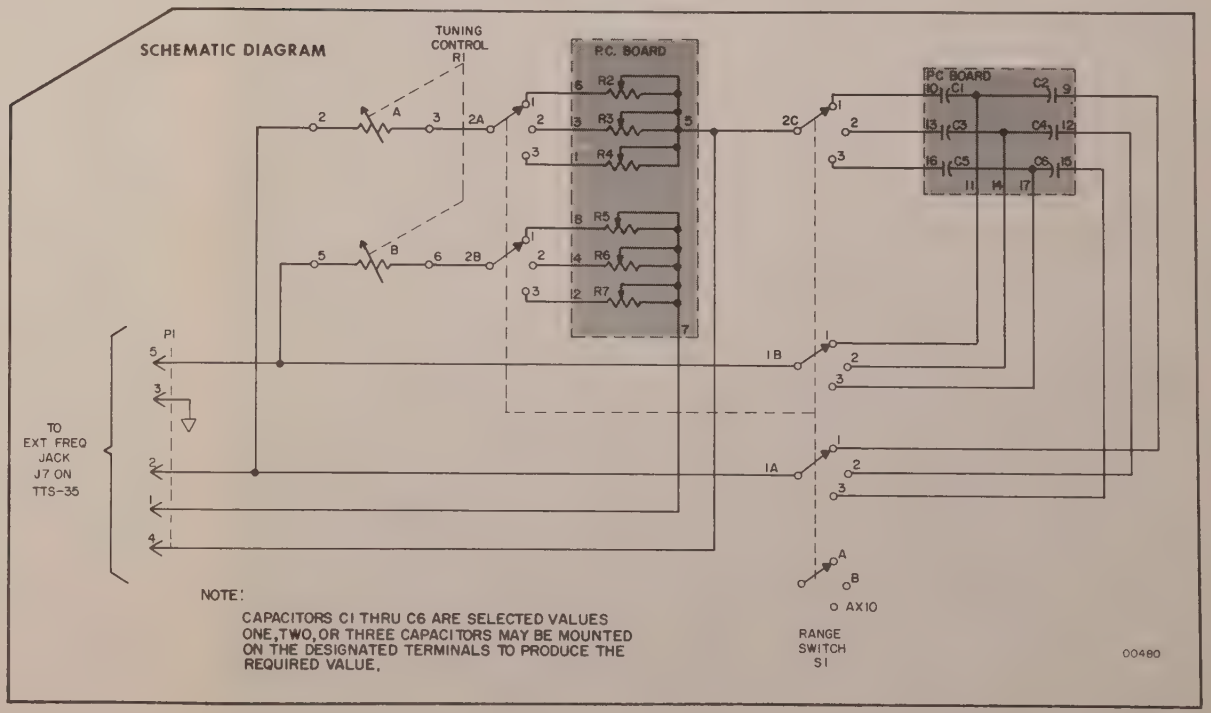


Figure 7—29. TTS-35XV Continuously Variable Frequency Adapter Practical Wiring Diagram, Parts Location And Schematic Diagrams

SECTION 8

PARTS LISTS

8.1 This section contains parts lists for the TTS-35 Series test sets and accessories.

Table 8—1. Overall Assembly Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
BP1	BINDING POST-RED				GRAYHILL	29-1R	652400400
BP2	BINDING POST-BLK				GRAYHILL	29-1B	652400300
BP3	BINDING POST-RED				GRAYHILL	29-1R	652400400
BP4	BINDING POST-BLK				GRAYHILL	29-1B	652400300
BP5-6	TEST JACK,BLK				RAYTHEON	TJ105BL	650600100
BP7	BINDING POST METAL GND				H H SMITH	137SP	652500100
CB1	INPUT IMPEDANCE BD. (SEE TABLE 8—7)						A003520006
CB2	QUIET TERMINATION ASSY (SEE TABLE 8—8)						A003520037
CR1	D041 (P/O J5)	1A	SI	400V	EDAL	IN4004	560040040
CR2-3	A1AY	1W	10%	18V	MOTOROLA	1N4746	562004746
C3A	100UF			150V	SPRAGUE	TVA1420	300401071
C3B	100UF			150V	SPRAGUE	TVA1420	300401071
E1-2	PROTECTOR S/V GAS				SIEMENS	B1-C90/20	566009020
F1		.3A		250V	LITTELFUSE	3AG	863100200
J1-3	SPECIAL				SWCRFT	5J-1329	650401300
J4	SPECIAL				SWCRFT	5J-1192	650401000
J5	JACK,TEL,SWCRFT SCHEM 4				SWCRFT	12B	650101000
J6	SPECIAL				SWCRFT	5J-1191	650400900
L1-2	4H				NEWTON	TN-1274	450200200
M1		1MA	2%		BEEDE	902121	900100300
P1	5-PIN FEM RECEPT-PANEL				SWCRFT	61GA5F	652300200
P2	6 COND				AMP	1-480270-0	650800200
PC1	AMP 1 E-95030 PC BD (SEE TABLE 8—2)						A003520004
PC2	AMP 2 E-95031 PC BD (SEE TABLE 8—3)						A003527015
PC3	OSC BD 95155 ASSY (SEE TABLE 8—4)						A003520027
PC4	QRMS DETECTOR ASSY (SEE TABLE 8—5)						A003527029
PC5	NOTCH FILTER ASSY (SEE TABLE 8—6)						A000110016
R8	4530-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220245311
R10	750-	3W	5%		OHMITE	4418	210307515
R19	680-	3W	5%		W LEONARD	TYPE 3X	210306815
R101	5K	2W	10%		CLAROSTAT	CM38414	230805023
R310	680-	1/2W	5%		AB	TYPE EB	200206815
S1-2		300W			SWCRFT	11206L	640100100
S3	S3&S4						A003520014
S4	S3&S4						A003520014
S5	4C-4C	CONTACT			S CARLSON	173P	630100700
S6		300W			SWCRFT	11212L	640100500

Table 8—1. (cont'd)

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
S7	4C-4C	CONTACT			S CARLSON	173P	630100700
S8	(SEE TABLE 8—10)						A003520021
S9	(SEE TABLE 8—11) NG						A003527013
S10	(SEE TABLE 8—12)						A003520020
S11		250MA		115V	GRAYHILL	46-200R	635500100
S12	2C-2C	CONTACT			S CARLSON	173N	630100600
S13	(P/O R101 ABOVE)						
S14	(SEE TABLE 8—13)						A003538010
S15		300W			SWCRFT	11206L	640100100
S16		300W			SWCRFT	11212L	640100500
T1	P50 TO 600 S50K SPLIT				NESHAMINY	AF-672	400200100
XF1	FUSEHOLDER 3AG CHASSIS				LITTELFUSE	357001	863000200
	CASE ASSEMBLY				NEC		A003520299
	FOOT, RUBBER, LG.				AIR	18	836500200
	FOOT, RUBBER, SM.				AIR	1322	836500300
	BATTERY, ALKALINE, D SIZE				EVEREADY	E-95	910200100
	BATTERY TRAY						D003520109
	BATTERY COVER						C003520114
	BATTERY HOLDER, 3 CELL				KEYSTONE	2199	916000200
	COVER, STANDARD						A003520298
	HANDLE, CASE				PHC	2200-131	856200100
	CATCH/STRIKE SS				NEILSON	SC-B-83314-2SS	856700100
	SWITCH, SHUTOFF						A003730103
	COVER, DEEP						A003520297
	FOOT, RUBBER, LG.				AIR	18	836500200
	HANDLE, CASE				PHC	2200-131	856200100
	CATCH/STRIKE, SS				NIELSON	SC-B-83314-2SS	856700100
	SWITCH, SHUTOFF						A003730103

Table 8—2. Receive Amplifier 1 (PC1) Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C101	20UF			25V	C. DUBILIE	NLW-20-25	300902060
C102	560PF		1%	500V	ELMENCO	CM20D561F	335105610
C105	20UF			25V	C. DUBILIE	NLW-20-25	300902060
C407	1.5UF		20%	200V	F-DYNE	MPE-1.5-200-20	320601550
CR102	DO35 4NS 10MA SI 50UA				FAIRCHILD	1N4148	560041480
L401	30MH	95MA	2%		TRIAD	EC-030	460100400
L402	30MH	95MA	2%		TRIAD	EC-030	460100400
L403	150MH	56MA	2%		TRIAD	ET-150	460100600
L404	250MH	95MA	2%		TRIAD	EC-250	460100500
Q102	TO92 350MW TC PNP			40V	MOTOROLA	2N3905	552039050
Q103	TO-92 350MW TA NPN			40V	MOTOROLA	2N3903	550039030
Q104	TO92 350MW TC PNP			40V	MOTOROLA	2N3905	552039050
R104	825K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220282531
R105	100-	1/2W	5%		AB	TYPE EB	200201015
R107	3.9K	1/2W	5%		AB	TYPE EB	200203925
R108	560K	1/2W	10%		AB	TYPE EB	200205646
R111	10K	1/2W	10%		AB	TYPE EB	200201036
R112	120K	1/2W	5%		AB	TYPE EB	200201245

Table 8—3. Receive Amplifier 2 (PC2) Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1	100UF			50V	C. DUBILIE	NLW-100-50	300901072
C201	20UF			25V	C. DUBILIE	NLW-20-25	300902060
C202	2UF			16V	SPRAGUE	TE1149	300202050
C203	5UF			16V	SPRAGUE	TE1152	300205050
C301	.50UF		10%	100V	SPRAGUE	225P50491YD3	320005040
C303-304	100UF			20V	CALLINS	7-65PSD100-20-S	300901071
C305	.1UF		00	75V	CENTRALAB	DDA-104	330201040
C306	20UF			25V	C. DUBILIE	NLW-20-25	300902060
C307	100UF			50V	C. DUBILIE	NLW-100-50	300901072
C308	1000PF		5%	500V	ELMENCO	CM20-E102J	335101021
CR1	A140	1W	1%	5.6V	SCHAUER	SZ5.6	562000560
CR301-305	A16Z	80MW	GE	50V	TRANS.	1N198	561001980
Q1	TO5	7W TA	PNP	65V	RCA	2N4036	552040360
Q2	TO92	350MW TC	PNP	40V	MOTOROLA	2N3905	552039050
Q201	TO92	350MW TC	PNP	40V	MOTOROLA	2N3905	552039050
Q202	TO-92	350MW TA	NPN	40V	MOTOROLA	2N3903	550039030
Q203	TO92	350MW TC	PNP	40V	MOTOROLA	2N3905	552039050
Q301-302	TO5	250MW TC	PNP	25V	TI	2N1374	553013740
Q303	TO92	350MW TC	PNP	40V	MOTOROLA	2N3905	552039050
R1	10K	1/2W	10%		AB	TYPE EB	200201036
R2	22-	1/4W	10%		AB	TYPE CB	200102206
R3	13.7K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220213721
R4	16.5K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220216521
R10	750-	3W	5%		OHMITE	4418	210307515
R13	27.4K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220227421
R14	1000#	125MW	1%		TEL LAB	CR16	211110011
R201	442K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220244231
R202	3.9K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220239011
R203	715K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220271531
R204	390-	1/2W	10%		AB	TYPE EB	200203916
R205	100K	1/2W	10%		AB	TYPE EB	200201046
R206	5.9K	1/2W	5%		AB	TYPE EB	200203925
R207	4.7K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220247011
R208	4.3K	1/2W	5%		AB	TYPE EB	200204325
R209	15-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220215091
R210	100-	1/4W	10%		AB	TYPE CB	200101016
R301	220K	1/2W	10%		AB	TYPE EB	200202246
R302	3.9K	1/2W	5%		AB	TYPE EB	200203925
R303	100-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220210001
R304	2K	1/2W	5%		AB	TYPE EB	200202025
R306	68K	1/2W	5%		AB	TYPE EB	200206835
R307	560-	1/2W	10%		AB	TYPE EB	200205616
R308	100-	1/2W	10%	200V	HELIPOT	62PR100	232701016
R309	200-	1/2W	5%		AB	TYPE EB	200202015
R311	200K	1/2W	5%		AB	TYPE EB	200202045
R312	10K	1/2W	10%		AB	TYPE EB	200201036
U1	8PDIL	00MW		180	SIGNETICS	UA741CV	500057410

Table 8—4. Oscillator Board Assembly (PC3) Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C151	20UF			25V	C. DUBILIE	NLW-20-25	300902060
C156-157	20UF			25V	C. DUBILIE	NLW-20-25	300902060
C159	20UF			25V	C. DUBILIE	NLW-20-25	300902060
C160	50UF			16V	SPRAGUE	TE1160	300205060
P102	500#	.5W	20%		CRL	TSC1BB501C	231205011
Q101-105	TO5	250MW TC PNP		45V	TI	2N1375	553013750
R150	39K	1/2W	10%		AB	TYPE EB	200203936
R152	3K	1/2W	5%		AB	TYPE EB	200203025
R153	200-	1/2W	5%		AB	TYPE EB	200202015
R154	1K	1/2W	10%		AB	TYPE EB	200201026
R155-156	100K	1/2W	10%		AB	TYPE EB	200201046
R160	62-	1/2W	5%		AB	TYPE EB	200206205
R161	68K	1/2W	5%		AB	TYPE EB	200206835
R163	2K	1/2W	5%		AB	TYPE EB	200202025
R164	820-	1/2W	10%		AB	TYPE EB	200208216
R165	2.2K	1/2W	5%		AB	TYPE EB	200202225
R167	853.81-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220285301
R169	1.7337K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220217311
R170	1.28K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220212811
R171	1.7337K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220217311
RT1-2	LAMP,WEIN BRIDGE				SYLVANIA	SEE DWG	730100301
T2	P600CT S600SPL AUDIO PC				UTC	S0-15P	400300200

Table 8—5. QRMS Detector Assembly (PC4) Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1	.22UF		10%	100V	SPRAGUE	225P22491XD3	320002240
C2	4.7UF		10%	25V	KEMET	T330A475K025AS	310004751
C3	10UF		10%	10V	KEMET	T330A106K010AS	310001060
C4	.01UF		10%	100V	SPRAGUE	225P10391WD3	320001030
C5	22UF		10%	15V	SPRAGUE	150D226X9015B2	310302260
C6	22UF		10%	15V	SPRAGUE	150D226X9015B2	310302260
C7	10UF		10%	20V	SPRAGUE	150D106X9020B2	310301060
C8	10UF		10%	20V	SPRAGUE	150D106X9020B2	310301060
C9	56UF		10%	15V	SPRAGUE	150D566X9015R2	310305660
C10	56UF		10%	15V	SPRAGUE	150D566X9015R2	310305660
C11	.1UF		00	75V	CENTRALAB	DDA-104	330201040
C12	20UF			50V	SPRAGUE	TE1305	300202061
CR1	DO35	4NS 10MA SI		50UA	FAIRCHILD	1N4148	560041480
Q1	TO-92	350MW TA NPN		40V	MOTOROLA	2N3903	550039030
Q2	TO92	350MW TC PNP		40V	MOTOROLA	2N3905	552039050
Q3	TO92	350MW TC PNP		40V	MOTOROLA	2N3905	552039050
Q4	TO92	350MW TC PNP		40V	MOTOROLA	2N3905	552039050
Q5	TO-92	350MW TA NPN		40V	MOTOROLA	2N3903	550039030
Q6	TO92	350MW TC PNP		40V	MOTOROLA	2N3905	552039050
Q7	TO-92	350MW TA NPN		40V	MOTOROLA	2N3903	550039030
Q8	TO92	350MW TC PNP		40V	MOTOROLA	2N3905	552039050
R1	4.7K	1/2W	10%		AB	TYPE EB	200204726
R2	330K	1/2W	10%		AB	TYPE EB	200203346

Table 8—5. (cont'd)

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
R3	100K	1/2W	10%		AB	TYPE EB	200201046
R4	6.8K	1/2W	5%		AB	TYPE EB	200206825
R5	15K	1/2W	5%		AB	TYPE EB	200201535
R6	15K	1/2W	5%		AB	TYPE EB	200201535
R7	5.6K	1/2W	10%		AB	EB	200205626
R8	1.2K	1/2W	10%		AB	TYPE EB	200201226
R9	1.2K	1/2W	10%		AB	TYPE EB	200201226
R10	100-	1/2W	10%		AB	TYPE EB	200201016
R11	33-	1/2W	5%		AB	TYPE EB	200203305
R12	33-	1/2W	5%		AB	TYPE EB	200203305
R13	3.3K	1/2W	10%		AB	TYPE EB	200203326
R14	3.3K	1/2W	10%		AB	TYPE EB	200203326
R15	820-	1/2W	10%		AB	TYPE EB	200208216
R16	120-	1/2W	10%		AB	TYPE EB	200201216
R17	100-	1/2W	10%	200V	HELIPOT	62PR100	232701016
R18	100-	1/2W	10%		AB	TYPE EB	200201016
R19	180-	1/2W	10%		AB	TYPE EB	200201816
R20	220K	1/2W	10%		AB	TYPE EB	200202246

Table 8—6. 1010 Hz Notch Filter Assembly (PC5) Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1	2.2UF		10%	35V	KEMET	T330A225K035AS	310002250
C2	3.3UF		10%	25V	KEMET	T330A335K025AS	310003350
C3	2.2UF		10%	35V	KEMET	T330A225K035AS	310002250
C4	120UF	G	10%	15V	SPRAGUE	196D127X9015TE4	310801270
C5	2.2UF		10%	35V	KEMET	T330A225K035AS	310002250
CR1-3	D035 4NS 10MA SI		50UA		FAIRCHILD	1N4148	560041480
FL1	1010 HZ				ESC ELECT.	ESC 42F86	470100700
Q1	TO92 350MW TC PNP			50V	MOTOROLA	2N5087	552050870
Q2	TO-92 350MW TA NPN			25V	MOTOROLA	2N5089	550050890
Q3	TO92 350MW TC PNP			25V	MOTOROLA	MPS6519	552065190
R1	590K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220259031
R2	464K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220246431
R3	604-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220260401
R4	619-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220261901
R5	14.7K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220214721
R6	48.7K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220248721
R7	3480-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220234811
R8	3740-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220237411
R9	5K	1/2W	10%	200V	HELIPOT	72PMR5K	232705023
R10	2430-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220224311
R11	4.7K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220247011
R12	1K	1/4W	10%		AB	TYPE CB	200101026
R13	56-	1/4W	10%		AB	TYPE CB	200105606
R14	14.7K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220214721
R15	1K	1/4W	10%		AB	TYPE CB	200101026
U1	8PDIL				NAT. SEMI	LM741CN	500007412

Table 8—7. Input Impedance Board (CB1) Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
R1-2	42.2K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220242221
R3	475-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220247501
R4	475-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220247501
R5	316-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231601
R6	316-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231601
R7	1.0845K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220210811
R9	84.5K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220284521

Table 8—8. Quiet Termination Assembly (CB2) Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLT	MFGR	MANUFACTURER PART NUMBER	N.E.C. PART NO.
R16, R17	300-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220230001
R15, R18	600-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220260001
C4, C5	2UF			200V	F-DYNE	MPE11-2.0-200-10	301302050
CB2	FILTER BD 35B						970196392

Table 8—9. Capacitor Assembly (C161) Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C161	50UF			75V	TSI	PA50LR75NP	301305061
	CAPACITOR MTG BD						A000420128

Table 8—10. S8 Switch Assembly Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
R601	1.02K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220310217
R602	3.24K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220332417
R603	10K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220310027
R604	475-	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220347507
R605	14.134K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220314127
R606	14.134K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220314127
R607	475-	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220347507
R608	475-	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220347507
R609	31.6K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220231621
R610	5.62K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220356217
S8		1A		28V	OAK	269426-F6	625801000

Table 8—11. S8 Switch Assembly Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C409-412	.0068UF		10%	100V	SPRAGUE	225P68291WD3	320006820
C413	.04UF		10%	100V	SPRAGUE	225P40391WD3	320004030
C414	.04UF		10%	100V	SPRAGUE	225P40391WD3	320004030
R402	1.8K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220218011
R404	1270-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220212711
R405	620-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220262001
R406	620-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220262001
R407	562-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220256201
R408	1.2K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220212011
R409	1.2K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220212011
S9	7D-2CKT-6 POS NONSHORT				OAK	269722-F7	625801500

Table 8—12. S10 Switch Assembly Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
R501	66.5-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220266591
R502	59-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220259091
R503	52.3-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220252391
R504	46.4-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220246491
R505	41.2-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220241291
R506	36.5-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220236591
R507	33.2-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220233291
R508	29.4-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220229491
R509	26.1-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220226191
R510	22.6-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220222691
R511	187-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220218701
S10	2D-1CKT-12 POS SHORT				OAK	269428-J20	626200100

Table 8—13. S14 Switch Assembly Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
R101	178K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220317837
R102	13.7K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220313727
R103	137K	1/8 W	.5%		ELECTRA	RN55 SIZE 100 PPM	220313737
R104	10.2K	1/2W	.5%		ELECTRA	RN55 SIZE 100 PPM	220310227
R105	113K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220311337
R106	7.87K	1/8	.5%		ELECTRA	RN55 SIZE 100 PPM	220378717
R107	57.39K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220357327
R108	3.809K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220338017
R109	26.97K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220326927
R110	1.654K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220316517
R111	26.1K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220326127
R112	1500-	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220215011
R113	23.7K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220323727
R114	1.37K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220313717
R115	21.5K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220321527
R116	1.27K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220312717
R117	21.5K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220321527
R118	1.27K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220312717
R119	20.554K	1/8W	5%		ELECTRA	RN55 SIZE 100 PPM	220320527
R120	1.18K	1/8W	.5%		ELECTRA	RN55 SIZE 100 PPM	220311817

Table 8—13. (cont'd)

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E.C. PART NO.
R121	750K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220275031
R122	178K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220217831
R123	143K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220214331
R124	866K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220286631
R125	205K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220220531
R126	909K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220290931
R127	200K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220220031
R128	511K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220251131
R129	158K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220215831
R130	1.3M	1/2W	5%		AB	TYPE EB	200201355
R131	30.9K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220230921
R132	442K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220244231
R133	232K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220223231
R134	698K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220269831
R135	681K	1/8W	1%		ELECTRA	RN55 SIZE 100 PPM	220268131
S14	4D-1CKT-11POS SHORT				OAK	269425-F4	625800900

Table 8—14. TTS-35XDT Dial And Talk Adapter Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1	.20UF		10%	100V	SPRAGUE	225P20491XD3	320002040
C2	.68UF		10%	200V	SPRAGUE	118P68492S2	320106840
CR1	D041	1A	SI	200V	EDAL	1N4003	560040030
CR2	D041	1A	SI	200V	EDAL	1N4003	560040030
J1	JACK,TEL,SWCRFT SCHEM 4				SWCRFT	L12P	650100300
J2	HI-D				SWCRFT	111	650100800
J3	HI-D				SWCRFT	111	650100800
L1	TALK COIL				CECO	CE-104A	450100100
MP1	COVER,TEL.DIAL				A E	D49929-A	835900100
R1	12-	1/2W	5%		AB	TYPE EB	200201205
R2	47-	1/2W	10%		AB	TYPE EB	200204706
S1	SPST	6A		125V	J-B-T	ST12A	620100100

Table 8—15. TTS-35XPS AC Power Supply Adapter Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1-2	100UF			150V	SPRAGUE	TVA1420	300401071
CR1-4	D041	1A	SI	200V	EDAL	1N4003	560040030
F1		.2A		250V	BUSSMAN	MDL	863101800
F2		.5A		250V	BUSSMAN	MDL	863101900
J1	JACK,TEL,SWCRFT SCHEM 4				SWCRFT	12B	650101000
J2	BINDING POST METAL GND				H H SMITH	137SP	652500100
R1-2	51-	1/2W	5%		AB	TYPE EB	200205105
S1	DPST				JBT	ST22K	620001000
T1		100MA			TRIAD	F-90X	420100100
XF1	FUSEHOLDER FUSE EXT				LITTELFUSE	341001	863000300
XF2	FUSEHOLDER 3AG CHASSIS				LITTELFUSE	357001	863000200
W1	6*18GA 3WIRE LINE				BELDEN	17236	932000200

Table 8—16. TTS-35XV Continuously Variable Frequency Adapter Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
MP1	SWITCH SHUT OFF BRKT						A003720110
MP2	FUDUCIAL						A000455101
PC1	PC BRD ASSY E95682						A001552005
PS1	5-PIN MALE PLUG RT ANGLE				SWCRFT	12DL5M	652300300
R1	1K-15K	2W	5%		WATERS	PT112W147	238001020
S1	AVOID IN NEW DESIGN 15XV				OAK	040100360102202A	626400200

Table 8—17. TTS-35XV PC Board Parts List

REFERENCE DESIGNATOR	DESCRIPTION VALUE	POWER	TOL	VOLTS	MFGR.	MFGR. PART NO.	N.E. PART NO.
C1	.12UF		10%	100V	SPRAGUE	225P12491XD3	320001240
C2	.033UF		10%	100V	SPRAGUE	225P33391WD3	320003330
C3	.0033UF		10%	100V	SPRAGUE	225P33291WD3	320003320
C4	.15UF		10%	100V	SPRAGUE	225P15491XD3	320001540
C5	.05UF		10%	100V	SPRAGUE	225P50391WD3	320005030
C6	.0082UF		10%	100V	SPRAGUE	225P82291WD3	320008220
R2-4	5K	1/2W	20%	200V	BOURNS	3386M-1-502	232705024
R5	500-	1/2W	20%	200V	BOURNS	3386M-1-501	232705012
R6	500-	1/2W	20%	200V	BOURNS	3386M-1-501	232705012
R7	500-	1/2W	20%	200V	BOURNS	3386M-1-501	232705012